

TABLE OF APPENDIX

APPENDIX 1 : BV- LAC PROJECT AND THE DIFFUSION OPERATORS	I
APPENDIX 2 : TYPOLOGY OF FARMS USED FOR THE FSRMN.....	V
APPENDIX 3: THE FARMING SYSTEM REFERENCE MONITORING NETWORK ..	VIII
APPENDIX 4 : THE SOFTWARE OLYMPE.....	X
APPENDIX 5 : SURVEY QUESTIONNAIRE	XIV
APPENDIX 6 : CONVENTIONS OF MODELING AND DEFINITIONS OF ECONOMIC TERMS	XX
APPENDIX 7: CLIMATIC CHARACTERISTICS OF THE ALAOTRA LAKE REGION	XXII
APPENDIX 8: INNOVATIVES STANDARD ROTATIONS AT THE ALOTRA LAKE	XXV
APPENDIX 9: THE STANDARD TECHNICAL PATHWAYS	XLIII
APPENDIX 10: EVOLUTION OF YIELDS AND OF RETURN TO LABOUR ACCORDING TO THE AGE IN CA.....	LIII
APPENDIX 11: MODELISED FARMS	LX
APPENDIX 12: ECONOMIC ANALYSIS.....	LXVII

Translations

Arachide: Groundnut
Concombre: Cucumber
CS: DS-dry season
Dolique: Dolichos
Haricot: beans
Jachère: Fallow
Maïs: maize
Manioc: Cassava
Maraîchage : vegetable growing
Marge brute/nette: Gross/net margin
Pomme de terre : potatoe
Patate douce: sweat potatoe
Pois de terre: Bombara nut
Riz pluvial: Upland rice
Solde (cumulé): (cumulated) cash balance
Tabac: Tobacco
Tomate: Tomato
Vesce: vetch

APPENDIX 1 : BV- LAC PROJECT AND THE DIFFUSION OPERATORS

❖ BV-LAC project

After Penot (2009)

The project « *Mise en valeur et de protection des Bassin Versants du Lac Alaotra* » was planned in 2000 and started in 2003. It is a pilot project in the framework of a national program of the MAEP « Watershed – irrigated perimeters ». It was conducted in two phases of 5 years. The MAEP is responsible for project management, while project management is delegated to CIRAD. Donors are the AFD and the Republic of Madagascar.

The project operates in the following areas:

- River watersheds of Imamba Ivakaka and west of Lake
- Upper watershed of southeast valleys
- Irrigation of the valley Marianina and PC15

The project objectives are:

- To increase and secure the income of producers
- Preserving the environment and secure investments for irrigation downstream
- Helping farmers to become actors in their development

To achieve these objectives, the project is implementing the following activities:

- **Security of land tenure:** an important condition for development activities, protection of the environment and improving productivity; this action only concerns for the moment an area of the region west of Lake in the land office implemented with the commune Amparafaravolo,
- **Preservation of ecosystems:** reforestation program involving agroforestry techniques and agro-ecology, treatment of gullies and *lavaka*, the fight against bushfires,
- **Agricultural development:** the promotion of agro-ecological techniques adapted to farmers' production systems, these techniques help to reduce erosion and restore soil fertility while allowing the development of new productive activities (market gardening, legume crops, etc.). Actions are specifically targeted at increasing rice through access to inputs, training in farming techniques saving seed, the spread of new seed varieties polyaptitudes (SEBOTA, FOFIFA) on PWCPF,
- **Integrating agriculture - livestock:** to reduce the high stress of cattle feed, and by measures to improve animal health,
- **Infrastructure projects:** opening, water supply and construction/rehabilitation of irrigation schemes having an immediate impact on improving the functioning of the irrigation network of two perimeters (PC 15 and Upper Valley Marianina).
- **Rural credit:** in connection with a bank located in the area (BOA) and micro-finance institutions,
- **Structuring peasant leadership,** training, organization and support to farmer organizations.

❖ BRL : BAS RHÔNE LANGUEDOC- MADAGASCAR

After Fabre, (2010)



Origin :

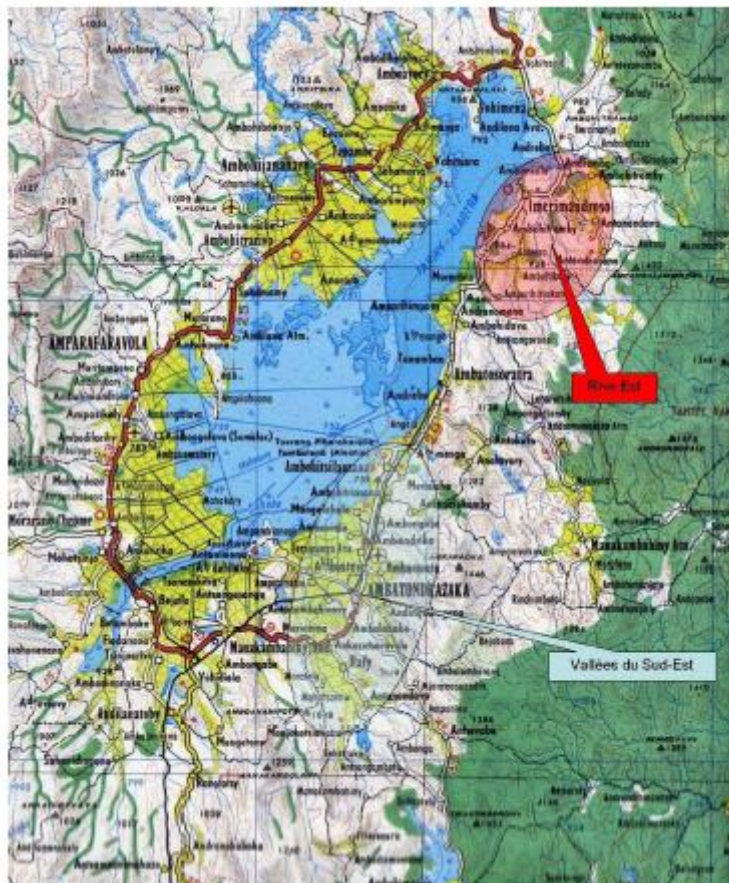
BRL (Bas Rhône Languedoc) was founded in 1955 as Regional Development Corporation. It is now a group sitting in Nimes (France) consisting of: the parent CNARBRL and its 4 subsidiaries: 1) BRL operating, 2) BRL ingeniering, 3) BRL natural areas, 4) BRL PREDICT services. BRL is responsible for water development in the south of France, but is also present in the world.

At Lake Alaotra, BRL is involved since the 1990s. He is responsible for water development, improved trails, and regional development overall. It supports the Federation of network users (FAUR : *Fédération des Usagers du Réseau*) in its management of irrigated rice growing areas. BRL begins broadcasting CA techniques in order to control (tanety) upstream against silting of irrigated perimeters. BRL Madagascar is a member and sieges on the Board of GSDM.

Organisation :

Dissemination of techniques were originally incorporated directly between farmers and technicians. Facing the growing demand for leadership, the organization of the diffusion was changed and was done by the group. Groups of direct seeding (GSD) were trained to respond to four objectives:

- Technical training
- Access to Information
- Supply of inputs
- Marketing of products



In addition, BRL has trained some farmers especially as Basic diffusion Agent (AVB : *Agent Vulgarisateur de Base*) to support the technicians in their work of disseminating techniques. BRL is staffed by agricultural engineers, technicians and AVB

Activities :

In 2003, BRL was contacted by the BVLac project to disseminate CA techniques on a larger scale around the lake. Their work area covers the eastern shore of Lake; SouthEast Valley (Valley Marianina, PC15) and the north east.

Intervention areas of BRL Madagascar in the framework of BVLac Alaotra project (Domas *et al.*, 2009)

❖ **AVSF : AGRONOMES ET VETERINAIRES SANS FRONTIERES**

After Fabre, (2010)



Origin :

Agronomes et Vétérinaires Sans Frontières is a french NGO born from the merging of *Vétérinaires Sans Frontières France* (AVSF-F) and the *Centre International de Coopération pour le Développement Agricole* (CICDA).

AVSF has development projects in South American, Africa and Asia. In Madagascar, AVSF provides for the project BVLac, originally two separate components: a management component of agro-pastoral resources and animal health component. These two parts merged in 2006 for a more holistic view of operations. Emphasis was placed on the qualitative aspect of the distribution of agro-ecological cropping system. AVSF is a member of GSDM since 2004.

Organisation :

AVSF has a project manager, assistants and technical supervisors of technicians in the field and also AVB.

Activities :

- Dissemination of CA techniques to the farms of all types,
- Grassing of steep areas,
- Installation of forage in crop rotations
- Construction of stable manure heaps
- Establishment of a network of community animal health auxiliaries (ACSA : Auxiliaires Communautaires en Santé Animale) around the lake. A total of 40 ACSA trained, assessed and equipped to operate in 14 communes on both sides of the lake. Their focus themes include: the prophylaxis of animals, the organization and facilitating meetings of awareness among farmers, the council improved farming village, epidemiological surveillance ...

❖ **ANAE : ASSOCIATION NATIONALE D' ACTIONS ENVIRONNEMENTALES**

After Fabre, (2010) ; GSDM, (2010)

Organisation:

ANAE is organised by *terroir* (appropriate space and set up by a community that contains all the natural resources (agricultural land, pastures, forests, land reserves ...) necessary for their subsistence): Each technician is assisted by a local technician mentoring and an AVB.

Activities:

ANAE work in the field of environmental, conservation and improving soil fertility by raising awareness, training and rural development (reforestation, conservation agriculture etc). ANAE began working with the project BVLac with a contract of reforestation and *lavaka* correction in 2004-2005. From 2005-2006, the ANAE shifted its actions on the dissemination of CA, it diffuses to the area west of the lake. ANAE is a founding member GSDM.

❖ **BEST : BUREAU D'EXPERTISE SOCIALE ET DE DIFFUSION TECHNIQUE**

After Fabre, (2010) ; GSDM, (2010)



Organisation:

The team is made up of over ten social organizers, responsible for all the groupments of a particular area, of social organizers responsible for all the super structures (federations), of a credit supervisor, the whole under the supervision of a coordinator.

Activities:

BEST office is in support of all operators for the technical implementation of farmers' organizations and their support. These groups facilitate trade of agricultural products and access to microcredit. BEST also controls, associations of water users. It also supported these groups in their efforts to access to bank loans and made tracking of repayments and recovery actions, in the Phase I BVLac.

❖ **L'NGO TAFE (TANY SY FAMPANDROASOANA)**

After GSDM, (2010)

TAFE means « *Terre et Développement* » for development component, testing and training in agroecology. Founded in 1994, the NGO ensures the development of a wide range of CA cropping systems in reference sites scattered in different agroecological zones representative of the island. Since 1999, this NGO is responsible for supporting the development agencies to better dissemination of cropping systems built with farmers.

❖ **ANDRI-KO**

After GSDM, (2010)

The cooperative Andri-KO, based at Alaotra Lake deals with the production and distribution of seeds for cash crops (rice, maize, beans...) and cover crops. Its members practice conservation agriculture in their plots for seed production. Andri-KO is a member of GSDM since 2009.

APPENDIX 2: TYPOLOGY OF FARMS USED FOR THE FSRMN

(After Durand et Nave, 2007)

I. Definition of types

Type A: Large rice growers

These farmers are specialized in rice production. They are self-sufficient and cultivate large areas of irrigated rice fields (3 to 6 hectares of rice fields). The *tanety* and *baiboho* are usually grown extensively and are always secondary to the rice fields. Permanent workers are generally employed on the farm to provide agricultural work. Farms are mechanized or motorized.

Type B: rice farmers with random yields

These farmers are self-sufficient in rice except for a few very bad years (= 0 yields the PWCPF). Rice fields are mainly PWCPF. To address this risk and secure income, they cultivate *tanety* and *baiboho* for sale with intensification and diversification. This additional income helps offset the risks on PWCPF. Farms are mechanized or motorized.

Type C: self-sufficient exploiting *tanety*

They are self-sufficient in rice but do not produce any surplus for sale. They have 1 to 3 ha of rice fields of type IPF or PWCPF. To generate additional income, they cultivate less than 3 ha of *tanety* and *baiboho* but very intensive and sell the products. Some are also developing small-scale livestock activities, or an off-farm activity to diversify their income. Farms are mechanized or motorized.

Type D: Farmers diversifying their production

They are not self-sufficient in rice each year because their fields are just like PWCPF and they have no more than 1.5 ha. So they seek a secure income by exploiting the *tanety* and *baiboho* they have. When they have at least 2ha, they cultivate cassava or fruit ... but when they have less than 1 ha, they develop off-farm activities and more. They often have a livestock (zebu cattle, pigs, poultry), which gives them a good integration of crop-livestock farming on their land. Agriculture is mechanized or motorized.

Type E: Not self-sufficient and farm workers

These farmers are never self-sufficient in rice, because they have very little rice field surface like IPF or PWCPF (less than 0.5 ha). Then they cultivate in a very intensive way, the single hectare of *tanety* and *baiboho* they have, which is their main source of income. This income does not cover family needs; they sell their labour to other farms. Farms are often mechanized.

F: Fishermen with farming

They are not self-sufficient in rice as they have less than 1ha of PWCPF. They have less than 0.5 ha of *tanety* and *baiboho*. That they cultivate intensively (rice, vegetables, tomatoes...) often with a view to sale. More importantly, they take advantage of their position near the lake (north east of the zone) to fish and thus earn income. Farms are often mechanized.

Type G: Landless Fishermen without agricultural activity

These are full-time fishermen and sale of fish is their only source of income. They have no land and only work for themselves, they are not self-sufficient in rice. However, they sell their labour as agricultural workers, especially during the fishing ban. This type is made up of farmers but of fishermen who supply the agricultural labour force and therefore interact with other types.

II. Principal determinant criteria

TYPES	CRITERE 1 : autosuffisance en riz lié aux types de rizières	CRITERE 2 : niveau de diversification avec d'autres productions	CRITERE 3 : type de main d'œuvre et activités off- farm
A : Grands riziculteurs	RI (5 ha) Autosuffisants en riz + vente	T (> 4 ha) Peu, voire pas cultivé Cultures extensives	MO temp > 300 H.j
B : Riziculteurs à rendements aléatoires	RMME décrue Autosuffisant en riz + vente	T/B (2-3 ha) : entièrement cultivés Moyennement intensif → objectif de vente	MO temp > 200 H.j
C : Autosuffisants exploitants les tanety	RI/RMME (2ha) Risque moyen Autosuffisant en riz	T/B (< 3ha) : entièrement cultivés Cultures intensives → objectif de vente	MO temp = 100 Off farm = services
D : Agriculteurs diversifiant leurs productions	RMME (1,5 ha) Risque ++ Autosuffisants (pas tous les ans)	T/B (1 à 2 ha) : entièrement cultivé Si 1 ha → off farm → objectif de vente Elevage	MO temp = 100
E : Agriculteurs non autosuffisants, ouvriers agricoles	Peu ou pas de RI/RMME Risque +++ Non autosuffisants	T/B (< 1 ha) : Cultures très intensives → objectif de vente	MO temp = 0 Off farm = ouvrier agricole
F : Pêcheurs pratiquant l'agriculture	RMME (1 ha) Non autosuffisant	T/B (< 0,5 ha) : Cultures intensives → vente et autoconso	MO temp = 0 Off farm = Pêche
G : Pêcheurs sans terre, sans activité agricole → Susceptibles de devenir type F	Sans terre Non autosuffisant	Sans terre	Ouvriers agricoles : fournissent de la main d'œuvre aux autres types

Source : Stefanie Nave et Claire Durand, 2007.

III. Economic indicators of different types

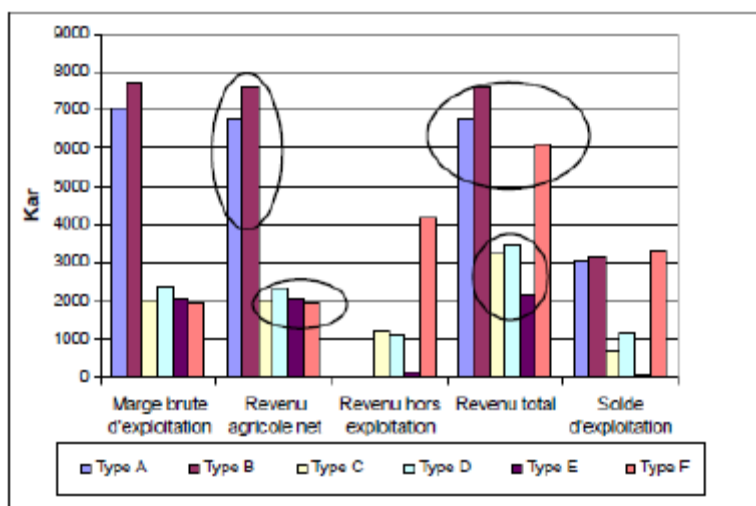


Figure 38: Comparaison des indices économique de tous les types

APPENDIX 3: THE FARMING SYSTEM REFERENCE MONITORING NETWORK

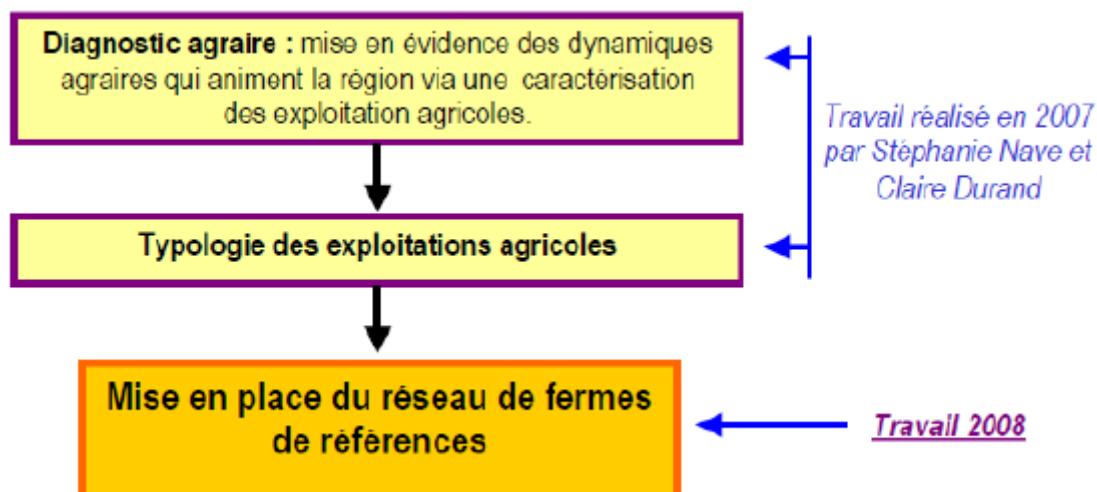
(After Terrier, 2008; Fabre, 2010)

⇒ **Context of implementation: an approach initially based on plot advising**

Dissemination of CA systems by the BV Lac project was initially done via a plot approach. Thus, the technical pathways were proposed for different soil types: for each major soil type fit a range of suitable technical pathways. These were the plots that were supervised and not on farms as a whole. Indeed, the role of culture (priority crop, cash or food...) or the repayment ability of the farmer was not considered in the proposed technical advice. However, the CA systems are, at least in the early years of cropping, complex systems and especially intensive in inputs (fertilizers, pesticides). They require in a vast majority of cases, a significant financial investment and therefore often lead the farmer into debt due to the contraction of agricultural credit.

⇒ **The farming system reference monitoring network: a tool of impact assessment and of individual advise**

1. THE STEPS OF CONSTRUCTION OF THE FSRMN



Methodological approach of the study of functioning and of the diversity of farms

2. DEFINITIONS

A farming system reference-monitoring network is a set of real case farms:

- Representative of different situations encountered in the agricultural area of project intervention. This representation is based on the typology of farms built by Stéphanie Nave and Claire Durand in 2007
- Followed every year by the operators of the project. The FSRMN is updated annually
- Supervised or not by the project BV Lac; unfarmed farms in the project serving as witnesses in the evolution of supervised farms by the project

- Modelled in software Olympe in the case of Lac Alaotra.

A reference farm is a representative of an actual farm type given in a given area, and modelled in the software Olympe on the basis of a detailed survey regarding:

- Installation and history of the farm
- Factors of production available (family labour and external labour, farm equipment, land and access to the different geomorphological units)
- Systems of perennial crops (fruit and timber)
- Systems for annual crops (rice, rainfed and dry-season) and their level of intensification
- Husbandry practices
- Revenues and expenditures of the family and the sources of non-farm income

The network of reference farms is updated annually; it allows measuring both qualitative and quantitative impact of project activities and the reallocation of factors of production that follows. This measure of impact can be achieved over time (comparison of the same farm over several years) as well as instantly as the network of reference farms covers both farmers supervised by the project and farmers in areas of action of the project but also unfarmed (control farms).

The establishment of this network provides technical and economic information necessary to the understanding of farmers' strategies such as: gross margins per hectare, the productivity of labour (family), return to labour (family) of the different cropping systems and the distribution of inputs of the activity system according to the constraints and opportunities of farmers.

3. OBJECTIVES OF FSRMN

The ultimate objectives are:

- To align the technical themes being developed by the project depending on the type of farm (adapted technical recommendations and the availability of credit depending on the type of farm, not only because of the plot)
- To provide basic information such as cost, quantities produced and marketed for members of farmers' organizations and thus give them access to a better ability to negotiate commercially
- To better understand the dynamics of land also, the impact of security and trajectories
- Anticipate the problems of marketing (price changes of products and inputs, market capacity to absorb the agricultural production of a particular product)
- To better estimate the possible degree of empowerment of the actors (producers and farmer organizations) based on economic performance actually observed.

APPENDIX 4: THE SOFTWARE OLYMPE

After Penot et Deheuvels (2007), Penot et al. (2003), Penot et al. (2004), Penot (2008).

What is the tool Olympe?

Olympus is a program that was developed primarily by J.M. Attonaty (INRA Grignon France) and by a wider community of researchers called the « Olympe Network » in collaboration with the IAM Montpellier, CIRAD and the IRD.

It is both a database, a calculator and a tool for modelling and simulating the operation of the farm, based on systems analysis, as defined cropping systems, animal husbandry, of activity and production data by Jouve et al. (1997).

Systemic approach: research methodology for agricultural systems

1 / Diagnosis => study of existing information (bibliography, database, key contacts)

Goal: To identify constraints and opportunities, income and labour productivity of each cropping system.

2 / Identification of possible scenarios to test a network of reference farms => integration of innovations tailored to the typology of farms (agronomic and socio-economic approach).

Goal: To eliminate the technical innovations in technical or social constraints (for organizational innovations)

3 / Modelling => modelling of reference agricultural systems

Goal: To simulate the technical change and adoption of innovation in order to assess the impact on farming systems and the externalities resulting in system-wide agricultural and regional

4 / Analysis and Integration research program => participatory approach: feedback with farmers

Goal: improved cropping systems and creating conditions conducive to the adoption and appropriation of innovations

It offers the possibility of a functional modelling of farming systems sufficiently detailed and precise to enable the identification of sources of income and production costs, the economic analysis of profitability based on the technical options (margins, balance sheets) and types of productions and monthly analysis of workforce needs.

It provides simulations of economic performance over several years, both by cropping system, farm or business at the farm level. In addition to the basic calculations automated, it is possible to create variables, indicators and output tables of custom data.

It allows the comparison of technical and economic results of farming systems but also between farms. It also makes it possible to place any technical or organizational innovation and its impact in the overall context of the farm, and even a small area.

(Penot 2008)

Outputs (10 years) Standards Bilan, CE, Cash balance, Physical Quantities (Monthly cash balance) Details: Capitalisation, Finance, Vat Work calendar On calculations (from 10 lines to several pages)
Graphs For 1 or N data according to the demand On a calculation over a set of data
The comparisons between different simulations For 1 or N data according to needs For a calculation over a set of data
Output to analyse: .CSV files reusable data: .XML files

Which conceptual model is based on?

The conceptual model used by Olympe is based on a systemic representation of agricultural systems widely used in conventional approaches of farming systems. It allows the study of a farming system economic and structural perspective. It has two main roles; figurative: represent the current system and demonstrative: exploring opportunities and farmers' strategies. This can be a decision support as a communication tool. It provides a synthetic economic vision of a complex agricultural system.

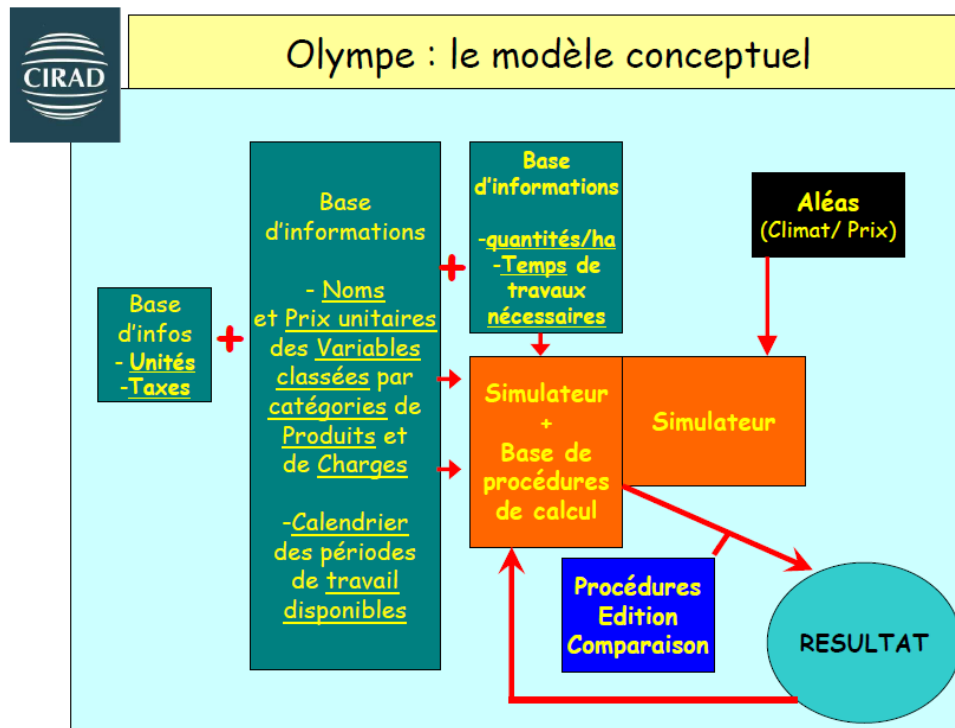
It represents the agricultural activities as a set of cropping and livestock specific and clearly marked.

- Cropping systems: annual, multiyear, perennial
- Livestock Systems
- Off-farm activities (any activity not directly associated with plant and animal)

Therefore, the model requires data on the structure and the various components of production factors in the farm income, expenses (operational, structural), externalities.

The global model (Penot *et al.* 2004)

Use of the model



(Penot 2008)

- Definition of products, expenses, externalities

Is defined in this part that can be described database, terms of income, expense, units and externalities that are then used in cropping systems or livestock system. A dictionary is available. This part of the software is actually a database on which to build other modules built (cropping / livestock / activities).

- The production system

To build a production system in Olympe, he must first define the income and expenses. These two elements are defined by their nature, their unit prices. Then each cropping system is characterized by the quantity of inputs used and production efficiency.

In this section are defined the different systems resulting in production:

- Cropping system: annual crops, perennial crops and semi-perennial crops (over 5 years: typically pineapple, banana or cassava.)
- Livestock system: animal production by type of animal or workshop
- System of activities (eg. processing...)

The software provides a cost-benefit analysis with the calculation of the margin/ha. We can then compare the profitability of each cropping system.

- The system of production (farm level)

The production system is described by the term "farmer" in Olympe. It is defined by a rotation, the area of perennial crops in which the planting year is specified, through its farming systems. The model incorporates the potential of production: fixed capital, expenditures and revenues of the family and other cash flows.

In this section are created farms that combine the different cropping systems, livestock or activities. Other revenues and expenses are also affected. The outputs are now automatic: the revenue-expenses, the CEG, the balance sheet etc....

What are the expected deliverables?

- Typology (= dynamic characterization) of farms

Olympe is a database or any data stored on farms in a given time. The sort keys in the module "package" to determine the types, adapt, and develop them according to the simulation over 10 years.

- **Farming system reference monitoring network**

The FSRMN is used to measure the impact of tests and techniques tested on the operation of the farm. Olympe to track a selection of farms that are the real FSRMN. We can then measure in real time the impact of any innovation or technical change.

- **Modelling of farms**

Two approaches are possible depending on the objective:

- Modelling of real farms to test real-time choices and technical assumptions that may lead to farmers' management board. The aim here is to work in real time with real farm or farms to have actual sufficiently representative if the agrarian situation is very homogeneous. Then it is a development tool.
- Theoretical farm modelling "average" representative "farm types", from a previous typology and validated by the farmers. This method provides a better understanding of complex situations and diverse, making them more readable. Then it is more a research tool and/or communication.

- **Facilities of scenarios**

Olympe allows the construction of scenarios based on assumptions of change crop management, diversification of cropping and livestock systems (crop selection, allocation of production factors: capital, labour, land) on price volatility, and climatic hazards. These scenarios can be simulated over 10 years. It can also test the "robustness" of a system of production in these scenarios face a series of hazards. It also recreate a past best known for explaining the (economic crisis) and to analyse in detail the positive and negative effects of a crisis on the incomes of farmers according to their type of crops, livestock...

Olympe is then a tool for decision support and technical advice: the value of crops (labour productivity, etc.). And how to integrate into the production system resulting in the questioning of its possible organisation?

- **Impact analysis**

The updated each year a number of indicators to track changes in farms linked to the introduction of an innovation. It is this function that is used in this study.

In conclusion

Olympe is used to analyse and understand farmers' strategies, their ability to innovate and to assess the viability of a farm. It is therefore an instrument to use to debate the acceptability of an innovation on a farm in terms of cash and human resources. It can also help assess the effects of innovation on a small area for projects or local decision makers.

APPENDIX 5: SURVEY QUESTIONNAIRE

L'enquête repose sur un questionnaire mais est menée comme un entretien semi-directif. On s'attache en effet tout au long de l'entretien à discuter et comprendre les informations quantitatives et qualitatives recueillies.

Partie I : l'exploitant (renseignements sur l'exploitation)

Nom/prénom de l'exploitant :

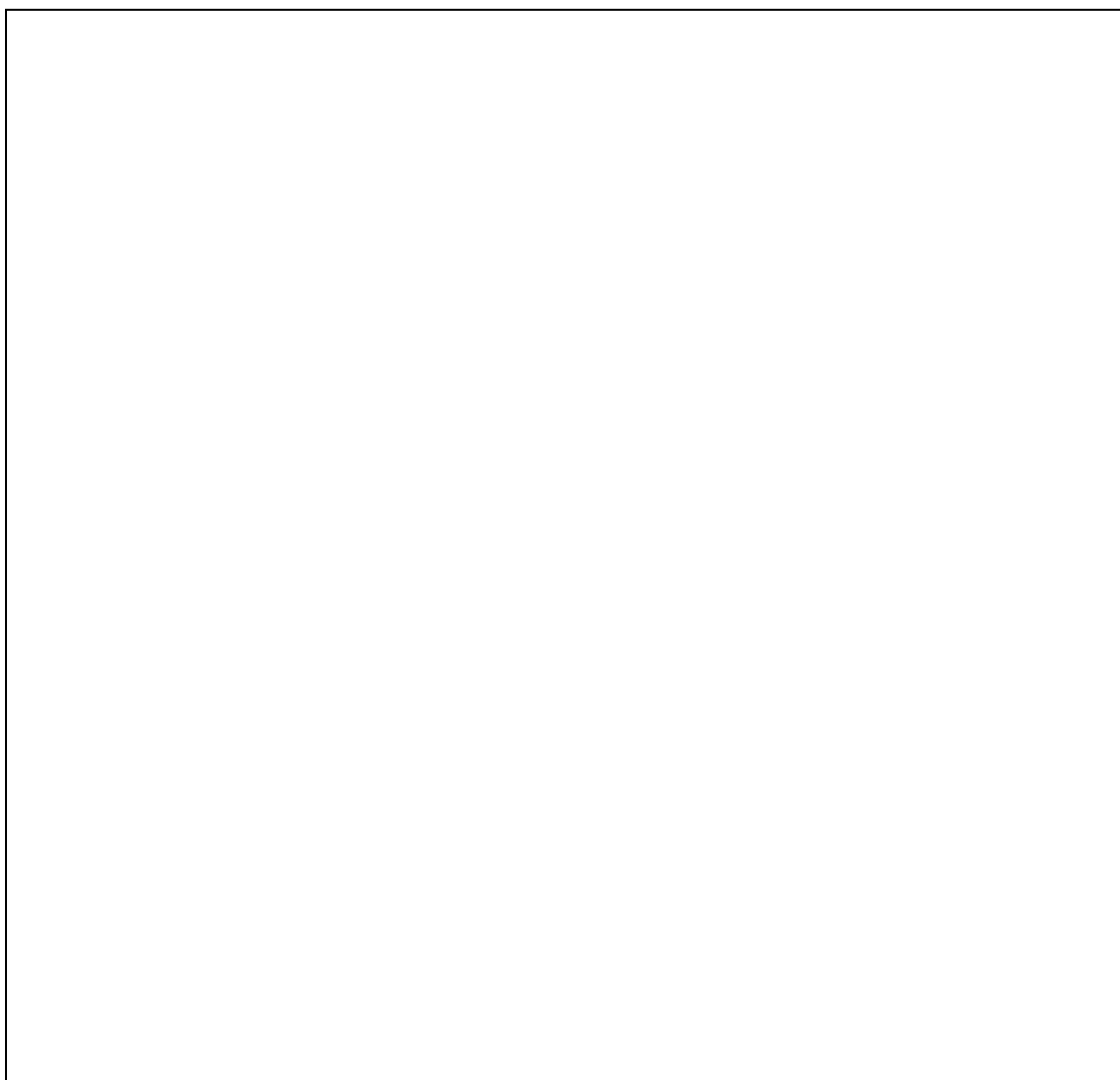
Fokontany :

Statut :

Opérateur :

Zone :

Parcellaire : *schéma du parcellaire total avec indication de la toposéquence, surface et système de culture actuel pour chaque parcelle (= > approche participative : un schéma des toposéquences de Durand et Naves, est montré au préalable à l'agriculteur puis il lui est demandé de dessiner ses plots s'il le souhaite)*



Note : dans la suite du questionnaire on ne s'intéresse uniquement aux plots en Baiboho et Tanety non CA

Autosuffisance en riz (oui, non) :

Nombre de zébus (préciser de traits ou capital) et porcs :

Revenu off-farm (si oui de combien) :

Partie II : les rotations sur Tanety et les Baiboho (systèmes non CA)

⇒ **Système de cultures (et variétés) et rendements (production totale, forme de la prod, prod vendue et autoconsommée, prix vente) par année, et par parcelle en BAIBOHO**

Parc	Surf parcelle + Précision de la toposéq (sableux ?)+indice de ferti à dire d'expert	2013 Prévision DS/S Raison du choix ?	2012 Prévision DS/S Raison du choix ?	2011 Prévision DS	2011-2010 S	2010 DS	2010-2009 S	2009 DS	2009-2008 S

2008 DS	2008-2007 S	2007 DS	2007-2006 S	2006 DS	2006-2005 S	Rotation + explication choix de cette rotation (agro ou opportunisme ?)

⇒ **Système de cultures (et variétés) et rendements (production totale, forme de la prod, prod vendue et autoconsommée) par année, et par parcelle en TANETY**

Parc	Surf parcelle + Précision de la toposéq+indice de ferti à dire d'expert	2013-2012 Prévision S Raison du choix ?	2012-2011 Prévision S Raison du choix ?	2011-2010 S	2010-2009 S	2009-2008 S

2008-2007	2007-2006	2006-2005	Rotation + explication choix de cette rotation (agro ou opportunisme ?)			
S	S	S				

Partie III : les ITK standards des systèmes de cultures non CA

⇒ Une grille par culture de saison et par culture de contre saison pour l'année
2010-2011

Système de culture (*nom culture, n°parc, surface cultivée, toposéq et année de réf*) :

Opération culturale	Date (préciser la quinzaine du mois)	Type d'intrant ou matériel	Quantité utilisée sur la surface cultivée	Coût 2011 (Ar/unité) si achat (noter si autoproduit)	MO familiale & salariale en nb homme x nb jours de travail	Coût 2011 MO sal (en Ar/pers/jour et préciser si à la tâche)
Travail du sol						
Fertilisation orga						
Fertilisation minérale						
Sowing ou repiquage						
Désherbages (chimique)						
Weeding 1(manuel)						
Weeding 2						
Sarclage 3						
Traitements phytos (insecticides, fongicides)						
Harvest						
Autre						

APPENDIX 6: CONVENTIONS OF MODELING AND DEFINITIONS OF ECONOMIC TERMS

The Olympe software terminology is the one used below. Olympe is based on a budget approach and works in **real cash**.

I) CONVENTIONS OF MODELING WITH OLYMPE

After Terrier *et al.*, (2008), Cauvy *et al.*, (2009)

- **Margin:** all the calculated margins are gross margins. Otherwise, we precise net margin.
- **Selfconsumption:** by convention selfconsumption is modeled as if the farmer sold and then bought back its production. The corresponding calculation is: quantities consumed * price at which the product was sold (if it was not consumed). This amount is within the family expenses. For rice, the price varies during the year. A weighted average of the quantity sold at whichever period, is conducted.
- **Off-farm:** it is the money earned by the family through work out (farm worker, transport, shopping ...). He may come into the family recipes.
- **The temporary external labour** is considered an operational expense.

II) DEFINITIONS OF FORMULA OF CALCULATIONS

After Penot *et al.* (2010). All calculations are done by hectare in Olympe.

- **Gross product value:** The gross product value is the gross agricultural product value estimated according to market prices (farm gate price: trading cost and transport are not included).
The field/plot gross product value is equal to the production multiplied by the product farm gate-selling price. Depending on the animal type, the animal production is calculated by summing the quantities of milk or meat produced per animal per year.
- **Operational costs:** Operational costs take in account all the direct expenses related the production of farm agricultural products, in particular: Seeds, manure, pesticides, Engine costs (fuel, oil), Water consumption, Tenant farming fees (land renting cost), Veterinary costs, animal feed and purchase, Temporary external labour costs.
- **Charges de structure (charges fixes) :** charges qui ne disparaissent dans l'acte de production ; location de bâtiment, matériel, personnel permanent ect.
- **Farm gross margin** = $\sum \text{activities} (\text{Gross margin}_{\text{activity}})$
The farm gross margin is equivalent to the **gross agricultural income**.
- **Net margin**
$$\text{Net margin}_{\text{activity}} = \text{Gross margin} - \text{Financial costs} - \text{Fixed costs}$$

- **Net agricultural income** = $\sum \text{activities} (\text{Net margin}_{\text{activity}})$
- **Total net income** = Net agricultural income + off-farm income

Les marges brute et nette représentent le revenu agricole avant autoconsommation. Elle permettent de comparer les exploitations entre elles. Cependant, cela ne reflète pas le revenu réel contrairement au solde de trésorerie

- **Cash balance** = total net income – family expenses (including selfconsumption). It represents the theoretical capacity of investment (actual balance after subtraction of all farm and family expenses). The cumulated cash balance over 10 years shows if the farm is capitalising or in relative stabilisation or if it is impoverished.
- **Labor productivity:** The labor productivity is equal to the production divided by the number of labor days required to achieve this production. For crop activities, it is expressed in kg of product per day.
It is a used to compare the efficiency and the productivity of 2 cropping systems or one cropping system during several years without distortion due to price fluctuation. It cannot be used to compare cropping systems with different productions (e.g. rice and corn) as the result is given in kg/ha.
- **Return to labour** = gross margin / days of family labour. It is expressed in kAr currency/days.
- **Intensification ratio (%)** = operational costs / gross margin. Expressed in %, it is a good indicator of the system intensity. It is generally around 30% for DMC systems. Over 50% the intensification ration is potentially dangerous.
- **Return to capital** = net margin / operational costs. It is a good indicator of risk. For instance, if the return to capital is under 50%, we can assume that the farm activity is too risky to go on (for a high intensification ratio) for such a low result.

APPENDIX 7: CLIMATIC CHARACTERISTICS OF THE ALAOTRA LAKE REGION

1. An erratic climate

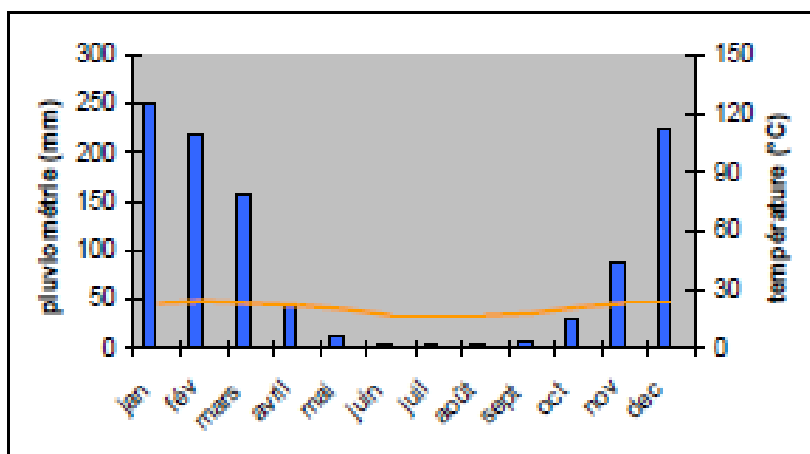
After Durand, C., & Nave, S., (2007)

The Lake Alaotra region is marked by a humid tropical climate of altitude (average annual temperature $> 20^{\circ}\text{C}$), contrasting sharply with two seasons.

The austral winter (dry season) from April to October is cool and dry (average temperature of 17°C). It is characterized by a strong water deficit and short days, preventing any double cropping of rice. In some areas the dry season cropping is possible by a water supply by rising water. The average minimum and absolute respectively below 15°C and 5°C from May to October. The winter (July and August) is marked by a cloud and drizzle frequent the following months (until November), the region between the period of minimum sunshine.

The austral summer (rainy season) from November to March is hot and humid (average temperature of 24°C) and records 80% of annual precipitation. This is the main growing season. In this period, the average maximum and absolute approach by 30°C and 35°C and maximum insolation occurs between January and June. The southern winter is characterized by high inter-annual rainfall variations in terms of quantity, distribution and duration of the season (dates of arrival and end of the rains variables). This variability leads to alternating campaigns very dry and very watered. There is also a spatial variability of precipitation. The area is subject to the wind of the trade winds, air masses from the ocean are, after drying and warming, become wet again above the lake plain. Overall the area west of the lake is more rain than the east bank (Teyssier, 1994).

Irregular climate is the first risk factor for farmers Lake Alaotra.



Ombrothermic diagram (Ambatondrazaka Station, period 1962-2005)

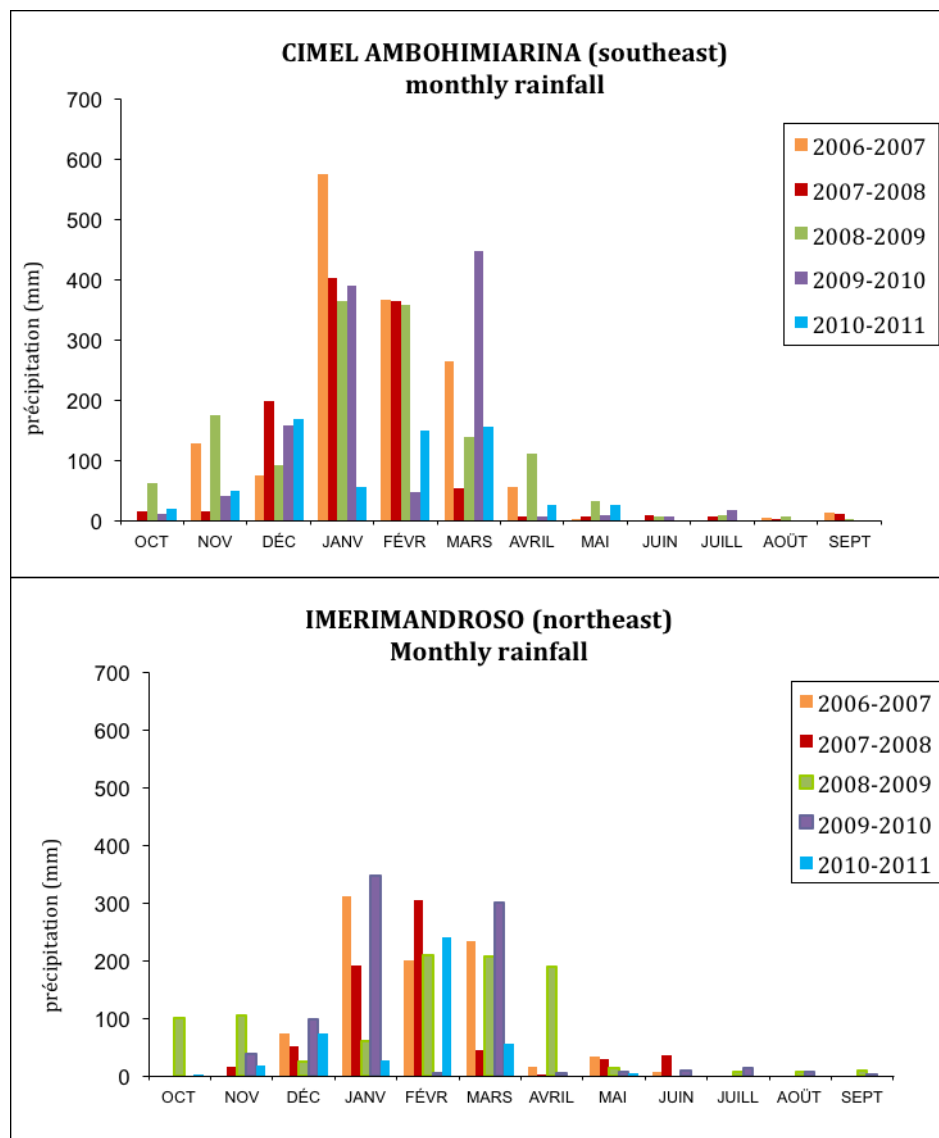
2. Caractéristiques of campaigns 2005-2006 to 2010-2011

The 2007-2008 and 2009-2010 campaigns are characterized by a short rainy season, rains and late rains stopped in March. For the 2009-2010 season, there is a deficit of rainfall in

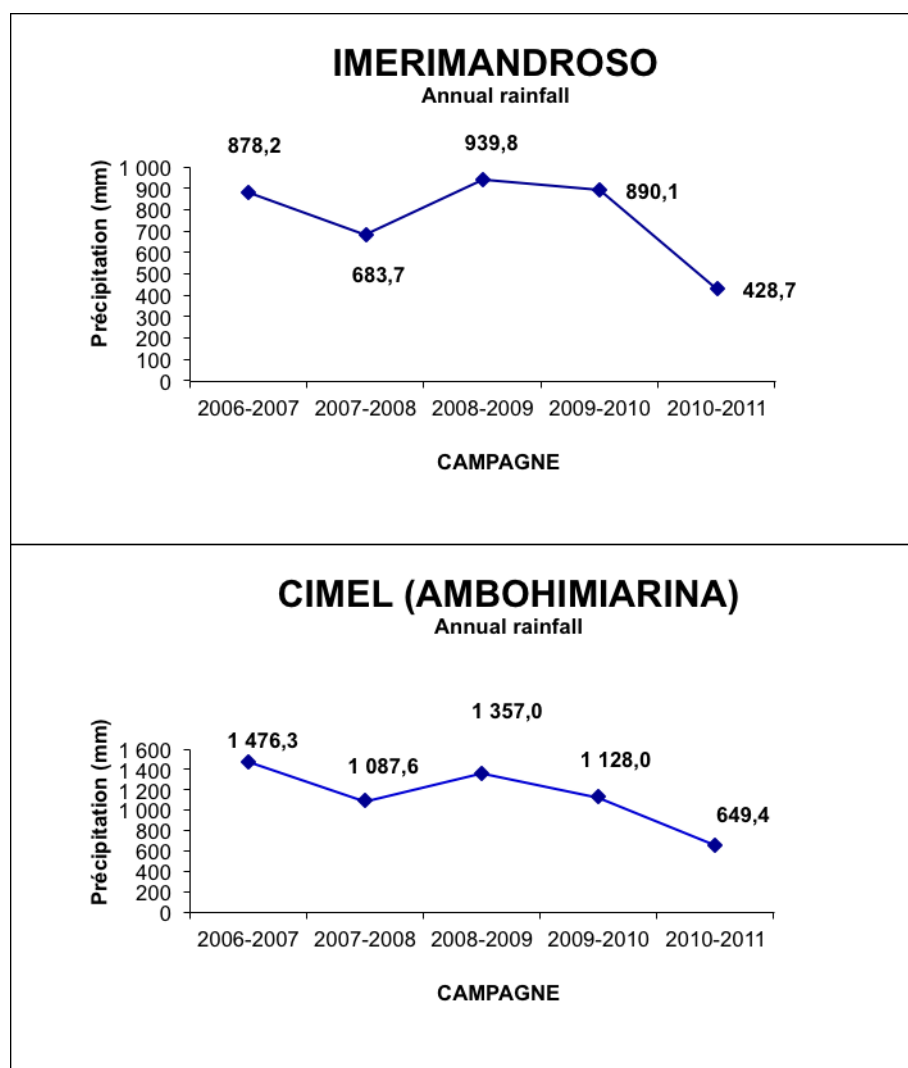
February and abundance in March (hurricane). Cumulative rainfall is slightly below normal over the past five years (1139 mm in the southeast).

The 2006-2007 and 2008-2009 campaigns are characterized by a normal rainy season (November to April), and normal and well distributed rainfall. Campaign 2010 -2011 is characterized by a normal rainy season but with very little rainfall (43% less in the south-east and 44% less in the north-east).

Rainfall in the valley of the southeast are 33% above average compared to the north-east.



Monthly-cumulated precipitations for the areas southeast and northeast



Annual cumulated precipitations for the campaigns 2006-2007 to 2010-2011, Southeast and northeast areas

In conclusion, the 2006-2007 season is considered a good year of agronomic point of view. The 2007-2008 and 2009-2010 campaigns are average years. The 2008-2009 campaign is a very good year. Finally, the 2010-2011 campaign is a very bad year.

APPENDIX 8: INNOVATIVES STANDARD ROTATIONS AT THE ALOATRA LAKE

For each zone, and each toposequence were first identified the crops most represented by effectives tables. These tables are constructed from pivot tables. The numbers represent the number of times a crop appears in one year. The ratio (%) indicates the proportion of a crop over the entire cultures informed by years. It allows to identify most represented crops a year (compared to crops indicated). The average ratio for each crop provides information on the crops most commonly used by farmers for all campaigns combined. Then a detailed qualitative analysis of the of the crop sequence in the 2011 survey database helped to define the standard rotation.

1. Zone Valley of the southeast

1.1. Baiboho

Zone	VSE												
Toposequence	Baiboho												
Sample: 40	Plots												
	Sais 05_06	Ratio	Sais 06_07	Ratio	Sais 07_08	Ratio	Sais 08_09	Ratio	Sais 09_10	Ratio	Sais 10_11	Ratio	MOY
Groundnut			1	11%	4	22%	9	32%	5	17%	3	10%	15%
Beans							3	11%			3	10%	3,5%
Fallow					1	6%	1	4%	3	10%	2	6%	4%
Maize			1	11%	3	17%	2	7%	1	3%	4	13%	8,5%
Cassava			1	11%	3	17%			5	17%	8	26%	12%
Bombara nut											1	3%	0,5%
Upland rice	7	100%	6	67%	7	39%	13	46%	16	53%	10	32%	56%
Total	7	100%	9	100%	18	100%	28	100%	30	100%	31	100%	

Table 1: Effectives and ratios of crops on baiboho for campaigns from 2005-2006 to 2010-2011

The table above indicates that upland rice is the crop most of this baiboho in the southeast. Groundnut crops and cassava are represented to a lesser extent.

There is a gradient of crop diversification for the 2006-2007 to 2010-2011. Instead of upland rice, although it still is the majority; it tends to be reduced since the 2006-2007 campaign. It can be hypothesized to higher input prices in 2008-2009.

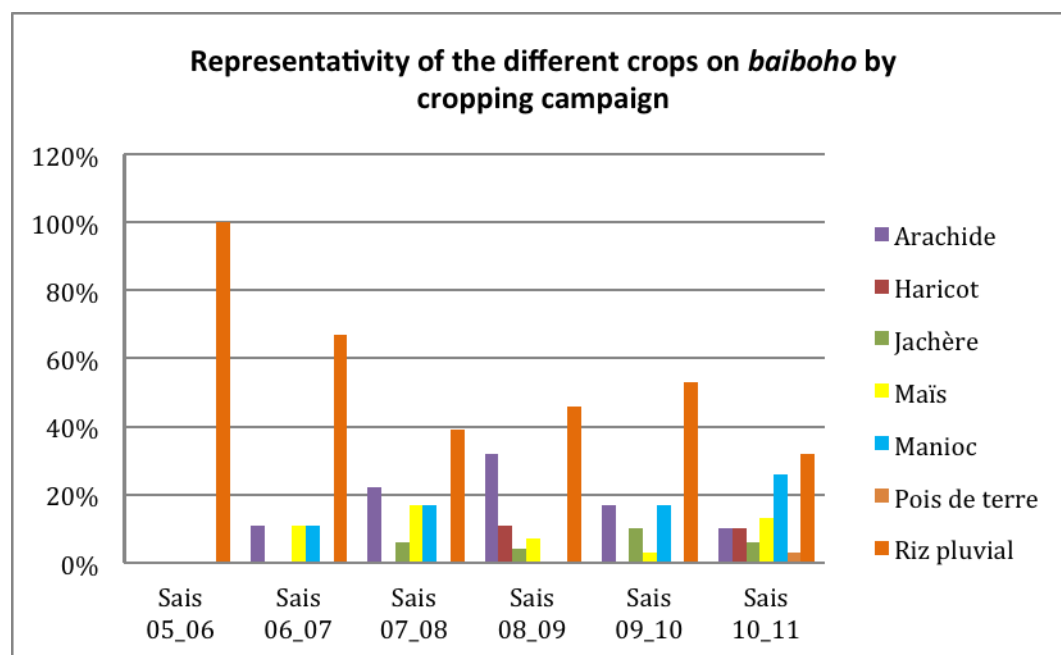


Figure 1: Ratios (%) of presence of each crop over the total of surveyed plots for each campaign

Note, however, the gradient of plots informed on all plots surveyed (40) since the 2005-2006 season until 2010-2011.

Zone	VSE										
Toposequence	<i>Baiboho</i>										
Sample: 22	plots										
	Cs 06	Ratio	Cs 07	Ratio	Cs 08	Ratio	Cs 09	Ratio	Cs 10	Ratio	MOY
Cucumber							1	8%	2	17%	5%
Beans DS	3	75%	3	75%	6	86%	8	67%	4	33%	67%
Sweet potatoes DS							1	8%	2	17%	5%
Potatoes DS	1	25%	1	25%	1	14%	2	17%	1	8%	18%
Tomato DS									3	25%	5%
Total	4	100%	4	100%	7	100%	12	100%	12	100%	

Table 2: Effectives and ratios of dry season crop on *baiboho* for campaigns from 2006 to 2011

Of the 40 plots of *baiboho*, only 22 plots have a dry season crop.

We observe a similar trend of crop diversification on the dry-season since 2006. The culture of bean in the dry-season is a majority, although its place has tended to decline since 2006.

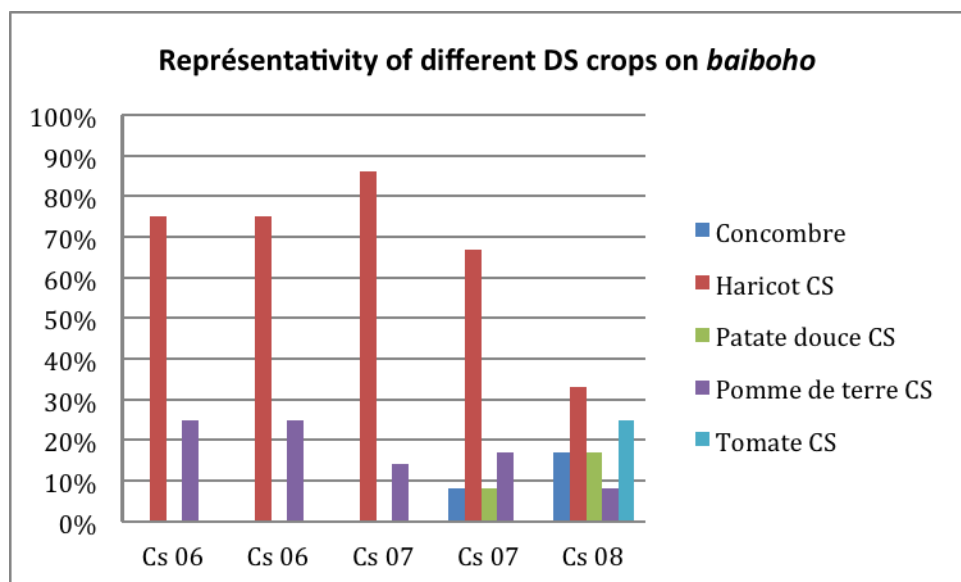


Figure 2: Ratios (%) of presence of each dry season crop over the total of surveyed plots for each campaign

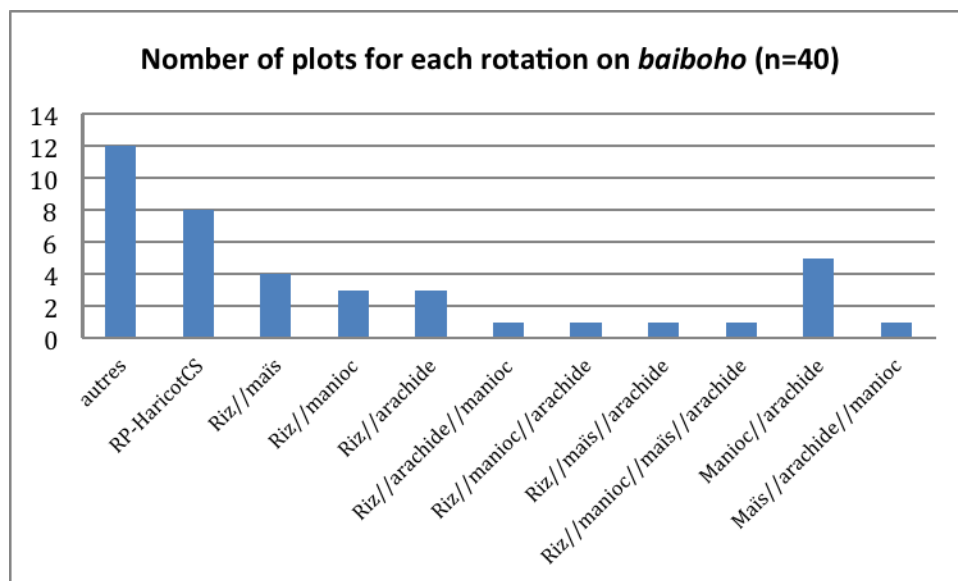


Figure 3: rotations on *baiboho* on the surveyed plots in 2011 (n=40)

Quantification of rotations observed since the 2006-2007 campaign until 2010-2011 of plots surveyed showed a wide range of rotations *baiboho*. The Upland rice-bean DS rotation and rotation Cassava//Groundnuts seem to be the most widely practiced by farmers. However, it should be noted that 14 of 40 plots have an inter-annual rotation with upland rice against six plots where rice cultivation is excluded. There is a preponderance of plots in the category "other". These are mainly monoculture crop sequences like Groundnut, corn, sugarcane, season beans, or fallow time.

The intra-annual rotation Upland rice-bean DS is on *baiboho* where soils remain wet due to capillary rise. Rotations incorporating inter-annual upland rice, are on sandy *baiboho*, not allowing the dry season crops (less rich soil, requiring more fertilizer on yield equal wet *baiboho*, water-holding capacity thus lower demands more frequent watering). This cropping system is less intensive and allows to obtain yields correct at low level of intensification (cf. 3. Technical pathways).

Given the complexity of inter-annual rotations with upland rice, the standard rotation established on *baiboho* is intra-annual **Upland rice-bean DS**.

1.2. Tanety Low Slopes (LS)

Zone	VSE													
Toposequence	Tanety BP													
Sample	: 9 plots													
	Sais 05_06	Ratio	Sais 06_07	Ratio	Sais 07_08	Ratio	Sais 08_09	Ratio	Sais 09_10	Ratio	Sais 10_11	Ratio	MOY	
Groundnut					3	43%	1	20%	2	33%	2	22%	20%	
Beans			4	67%	1	14%	1	20%	1	17%	2	22%	23%	
Maize							2	40%			1	11%	8,5%	
Cassava	1	100%			1	14%	1	20%	1	17%	2	22%	29%	
Upland rice			2	33%	2	29%			2	33%	2	22%	19,5%	
Total	1	100%	6	100%	7	100%	5	100%	6	100%	9	100%		

Table 3: Effectives and ratios of crops on tanety BP for campaigns from 2005-2006 to 2010-2011

The lower slopes represent about 25% of the cultivated area in the south, it has very few observations (9 plots surveyed).

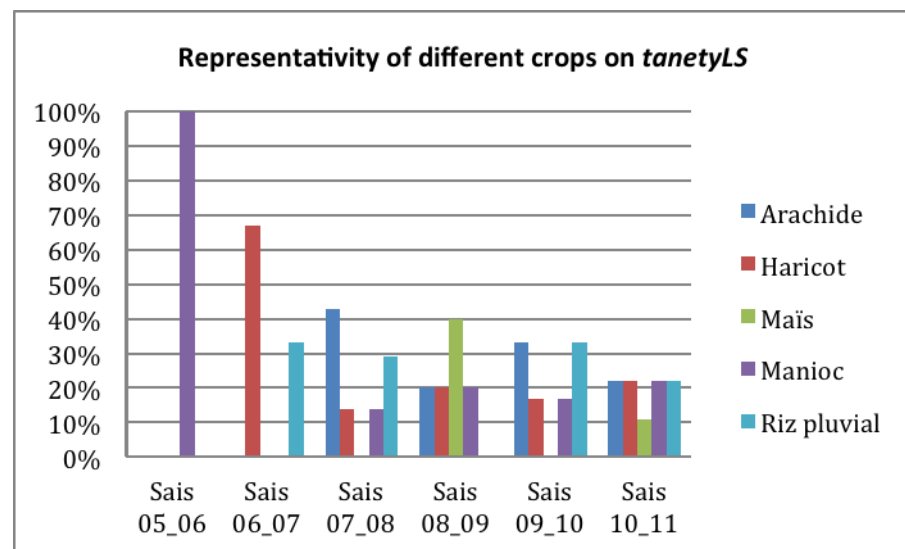


Figure 4: Ratios (%) of presence of each crop over the total of surveyed plots for each campaign

On the lower slope of *tanety* Groundnut crops, beans, cassava and upland rice are present in equal proportion for the 2010-2011 season. No evolution of crops over the campaigns is really observable.

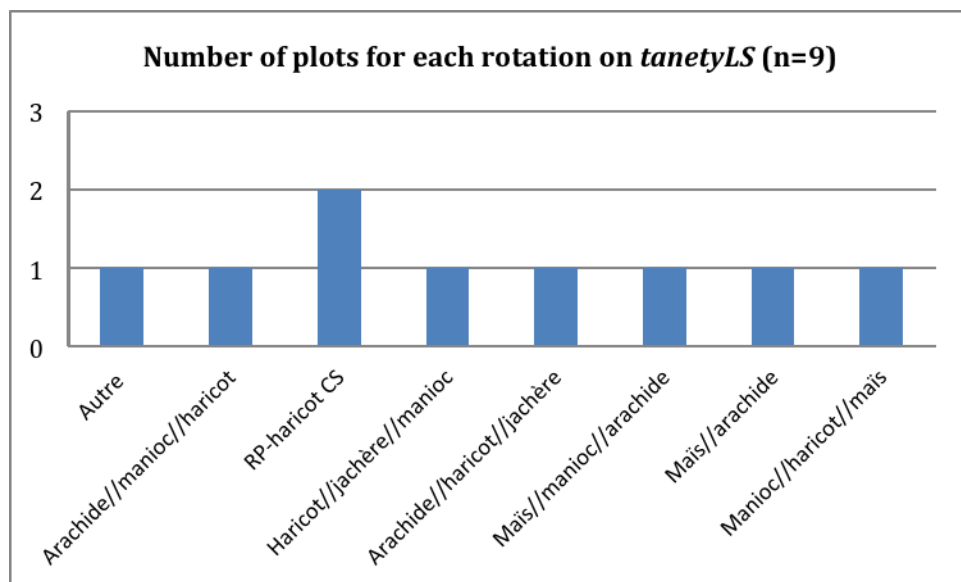


Figure 5: rotations on tanetyLS on surveyed plots in 2011 (n=9)

We observe from the graph above that two of the plots surveyed one has an intra-annual rotation Upland rice-bean DS, 4 plots have a variety of rotations including inter-annual crop season bean and 2 plots are composed of rotations maize, Groundnuts and cassava. Among the rotations including bean crops in descending order returning most often with beans are cassava>Groundnut>maize. The average ratio of all campaigns combined confirms this conclusion. The inter-annual rotation will be based on these three crops. The types of rotations established *tanety* downslope are:

- Intra-annual rotation Upland rice - DS beans on low fertile slope
- Inter-Groundnut Rotation // Cassava // Bean on low slope less fertile

1.3. *Tanety*

Zone		VSE											
Toposequence		Tanety											
Echantillon : 20 plots													
	Sais 05_06	Ratio	Sais 06_07	Ratio	Sais 07_08	Ratio	Sais 08_09	Ratio	Sais 09_10	Ratio	Sais 10_11	Ratio	MOY
Groundnut	1	10%	2	15%	2	13%	1	5%	3	18%	2	12%	12%
Beans			1	8%									1%
Fallow	2	20%	2	15%	1	7%	4	21%	1	6%	2	12%	13,5%
Maize	4	40%	3	23%	5	33%	6	32%	6	35%	4	24%	31%
Cassava	2	20%	3	23%	4	27%	4	21%	4	24%	4	24%	23%
Cowpea											2	12%	2%
Bombaranut			1	8%	3	20%	2	11%	3	18%	3	18%	12,5%
Upland rice	1	10%	1	8%			2	11%					5%
Total	10	100%	13	100%	15	100%	19	100%	17	100%	17	100%	

Table 4: Effectives and ratios of crops on *tanety* for campaigns from 2005-2006 to 2010-2011

It is observed that upland rice is rarely grown on *tanety*. The maize and cassava dominate. Groundnuts and bombara nuts are represented more weakly. Fallow is also quite present but no logic is apparent on its place in the rotation.

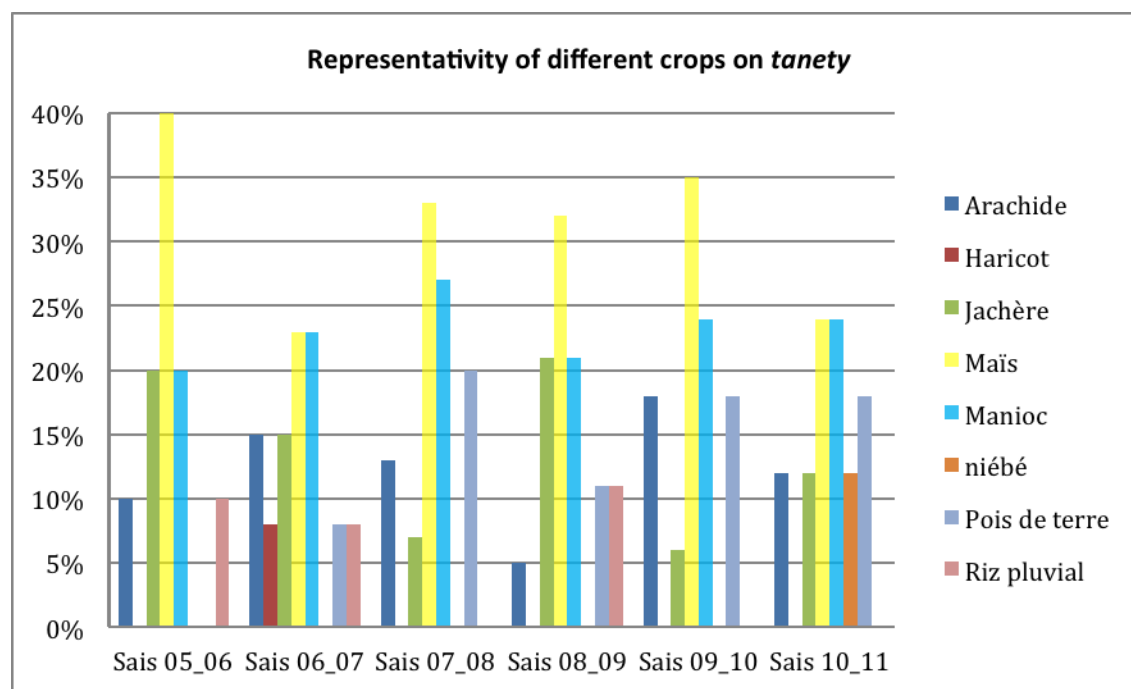


Figure 6: Ratios (%) of presence of each crop over the total of surveyed plots for each campaign

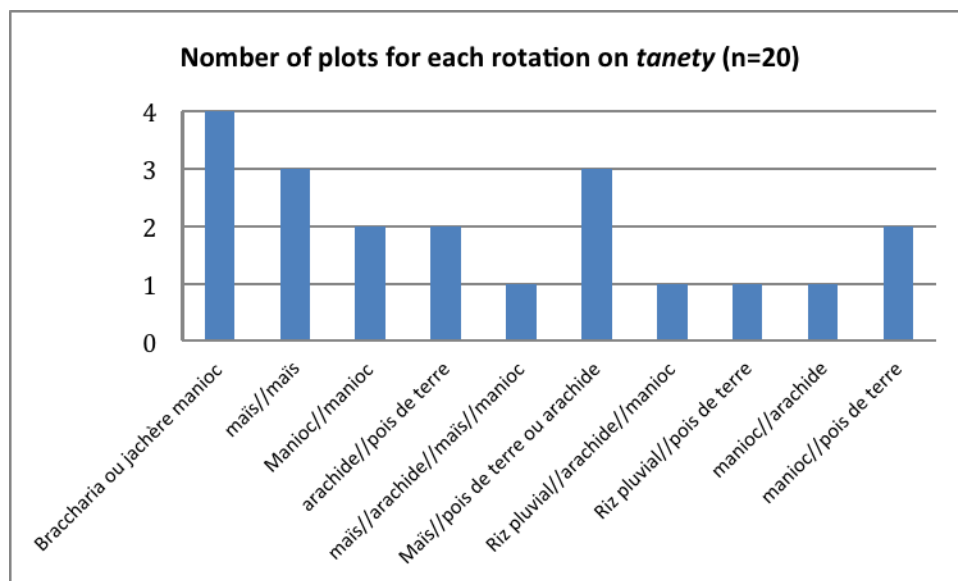


Figure 7: rotations on *tanety* on the surveyed plots in 2011 (n=20)

Note that the agronomic rotations are practiced on *tanety* at the rate of 50%. Indeed, 7 of the plots surveyed have a monoculture of maize, cassava, bombaranut/ Groundnut (these two crops are considered the same culture) against 7 plots where there are rotations. The rotations are diverse; the main crops are cassava, maize and groundnuts. We can determine a standard inter-annual rotation: Maize//Maize//Groundnut//Cassava.

2. Zone Northeast

2.1. Baiboho

Zone ZNE													
Toposequence <i>Baiboho</i>													
Sample: 12 plots													
	Sais 05_06	Ratio	Sais 06_07	Ratio	Sais 07_08	Ratio	Sais 08_09	Ratio	Sais 09_10	Ratio	Sais 10_11	Ratio	MOY
Fallow							1	9%			2	17%	4%
Maize	1	25%			1	12 %	2	18%	1	8%	2	17%	13%
Cassava	1	25%			2	25%			3	25%	1	8%	14%
Upland rice	2	50%	4	80%	5	63%	5	45%	7	58%	4	33%	55%
Tomato											1	8%	1%
Beans			1	20%			1	9%			2	17%	8%
Groundnut							2	18%	1	8%			4%
Total	4	100%	5	100%	8	100%	11	100%	12	100%	12	100%	

Table 5: Effectives and ratios of crops on *baiboho* for campaigns from 2005-2006 to 2010-2011

In the zone northeast, the cultivation of upland rice is mainly present on *baiboho*. We observe a similar trend of crop diversification as on the *baiboho* Southeast.

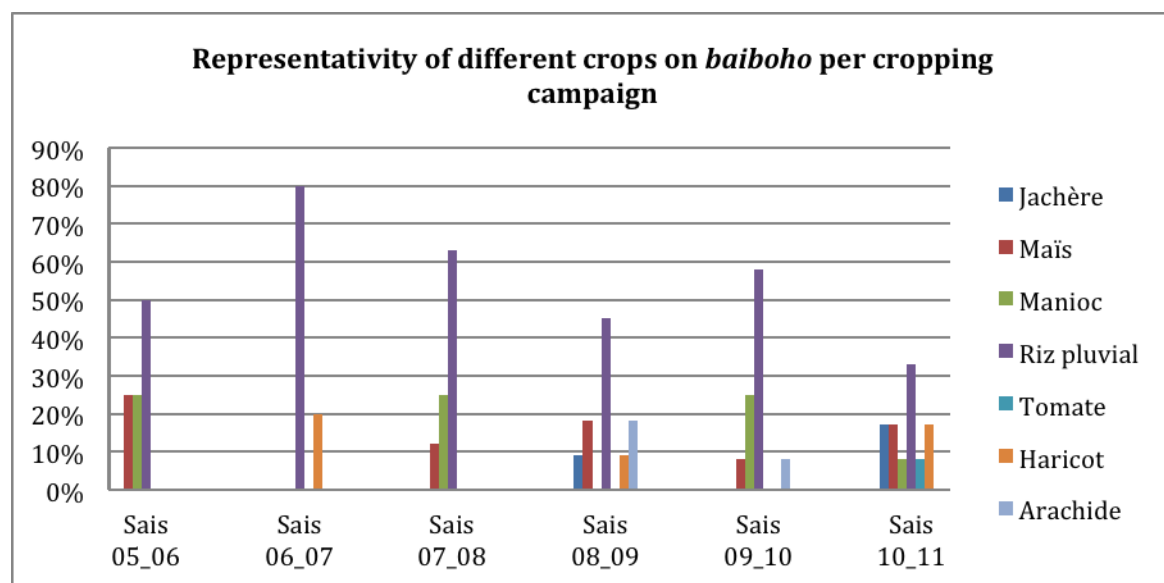


Figure 8: Ratios (%) of presence of each crop over the total of surveyed plots for each campaign

Zone	ZNE										
Toposequence	Baiboho										
Sample: 4 plots											
	Cs 06	Ratio	Cs 07	Ratio	Cs 08	Ratio	Cs 09	Ratio	Cs 10	Ratio	MOY
Beans DS			1	100%	2	100%	1	50%	2	50%	60%
maraîchage									1	25%	5%
dolichos							1	50%			10%
vetch									1	25%	5%
Total	0		1	100%	2	100%	2	100%	4	100%	

Table 6: Effectives and ratios of dry season crops on *baiboho* for campaigns from 2006 à 2011

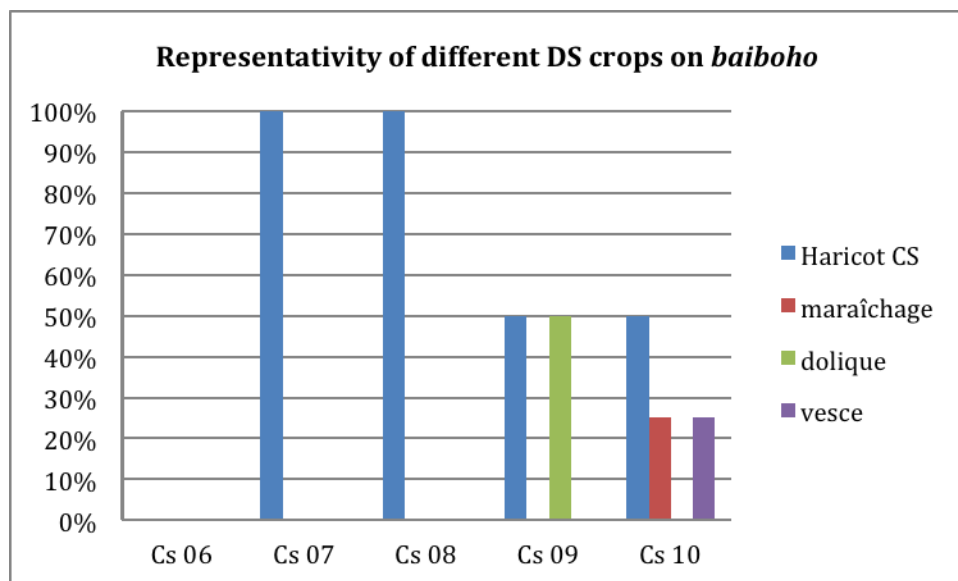


Figure 9: Ratios (%) of presence of each dry season crop over the total of surveyed plots for each campaign

In the dry season bean crop is mainly present on *baiboho*. It should be noted that during the interviews, farmers do not necessarily indicate a dry season crop on the plots in upland rice. Yet in practice, upland rice is frequently accompanied by dry season vegetable crop (especially tomato but also cucumber, peppers, eggplant).

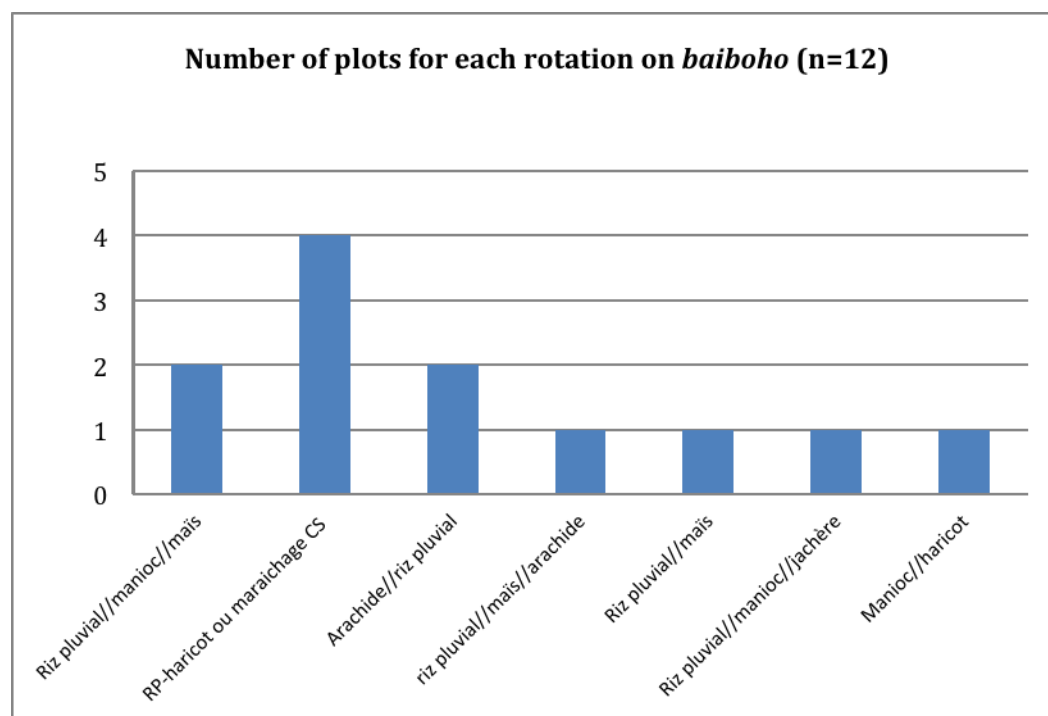


Figure 10: rotations on *baiboho* on surveyed plots in 2011 (n=12)

Note that unlike on the *baiboho* in the VSE area, there is no standard rotation on this toposequence in this area. Upland rice is included in almost all rotations *baiboho* (11 plots of 12). We distinguish the intra-annual rotation upland rice- dry season vegetables or beans; to annual rotation with crops of groundnuts, cassava or maize. The maize seems to come more often in rotations with upland rice. We can therefore identify two standard rotations:

- The intra-annual rotation Upland rice - beans DS on rich *baiboho*
- The inter-annual rotation Upland rice//maize//Groundnut// Upland rice//Cassava on poorer *baiboho*

2.2. Tanety lower slopes

Zone ZNE													
Toposequence Tanety BP													
Sample: 20 plots													
	Sais 05_06	Ratio	Sais 06_07	Ratio	Sais 07_08	Ratio	Sais 08_09	Ratio	Sais 09_10	Ratio	Sais 10_11	Ratio	MOY
Groundnut	2	18%			7	47%	3	15%	7	35%	7	35%	25%
Fallow					2	13%	3	15%	2	10%			6%
Beans	1	9%	1	11%	1	7%	1	5%	1	5%	2	10%	8%
Maize	5	46%	2	22%	2	13%	6	30%	2	10%	3	15%	23%
Cassava			1	11%			2	10%	2	10%	3	15%	8%
Bombaranut			1	11%							1	5%	3%
Upland rice			1	11%			5	25%	6	30%	4	20%	14%
Tabacco	3	27%	3	33%	3	20%							13%
Total	11	100%	9	100%	15	100%	20	100%	20	100%	20	100%	

Table 7: Effectives and ratios of crops on tanety BP for campaigns from 2005-2006 to 2010-2011

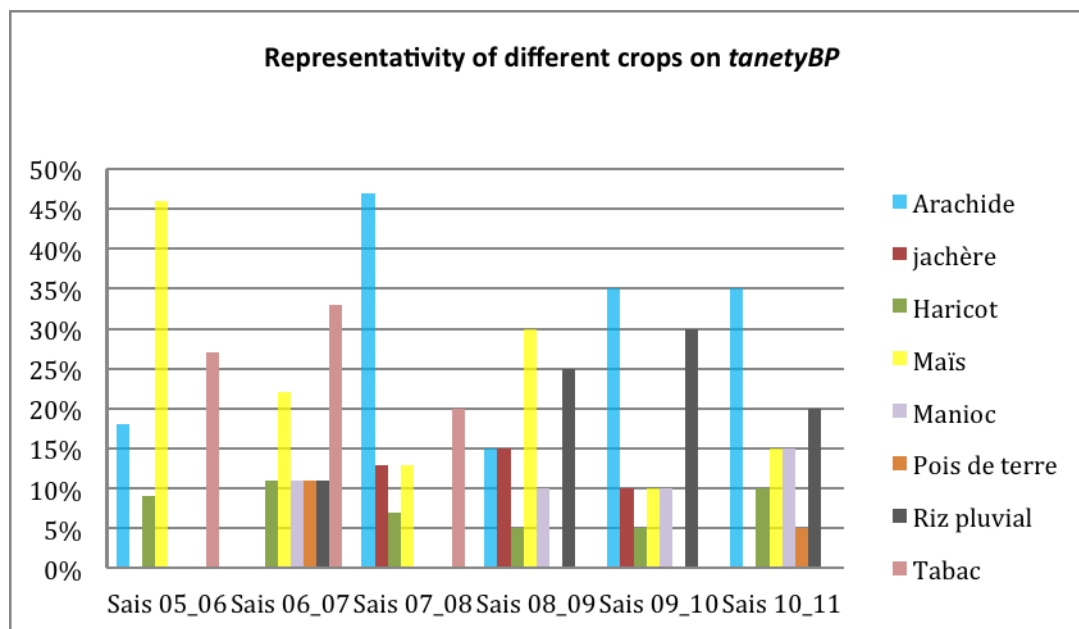


Figure 11: Ratios (%) of presence of each crop over the total of surveyed plots for each campaign

On the lower slope *tanety* of the northern area Groundnut crops and maize are found mostly. Upland rice is less represented. Tobacco is a traditional crop in this area, due to the presence of a cooperative at Imerimandroso. Most of the surveyed farmers have stopped growing tobacco for economic reasons.

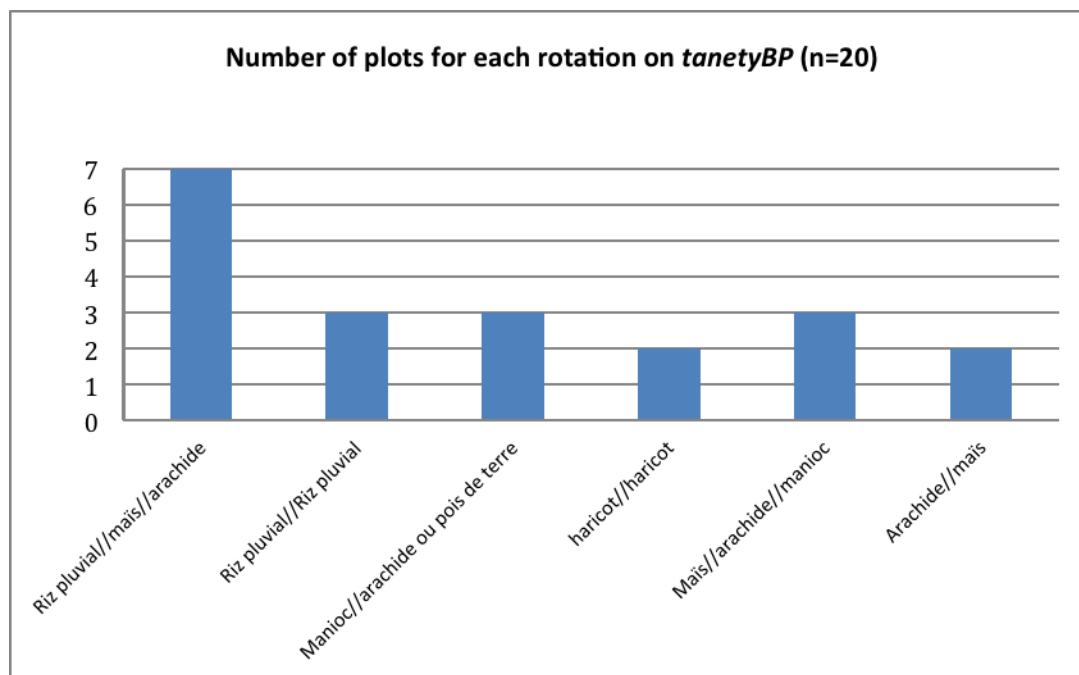


Figure 12: rotations on *tanety* BP on the surveyed plots (n=20)

The most observed rotation on downslope *tanety* is: Upland Rice // maize // Groundnut

2.3. Tanety

Zone ZNE													
Toposequence <i>Tanety</i>													
Echantillon : 8 plots													
	Sais 05_06	Ratio	Sais 06_07	Ratio	Sais 07_08	Ratio	Sais 08_09	Ratio	Sais 09_10	Ratio	Sais 10_11	Ratio	MOY
Groundnut	1	12,5%	1	12,5%	1	12,5%	1	12,5%	2	25%	3	37,5%	19%
Beans	1	12,5%	1	12,5%	1	12,5%	2	25%	1	12,5%	1	12,5%	15%
Maize	4	50%	4	50%	4	50%	4	50%	4	50%	3	37,5%	48%
tabac	2	25%	2	25%	2	25%	1	12,5%	1	12,5%	1	12,5%	19%
Total	8	100%	8	100%	8	100%	8	100%	8	100%	8	100%	

Table 8: Effectives and ratios of crops on *tanety* for campaigns from 2005-2006 to 2010-

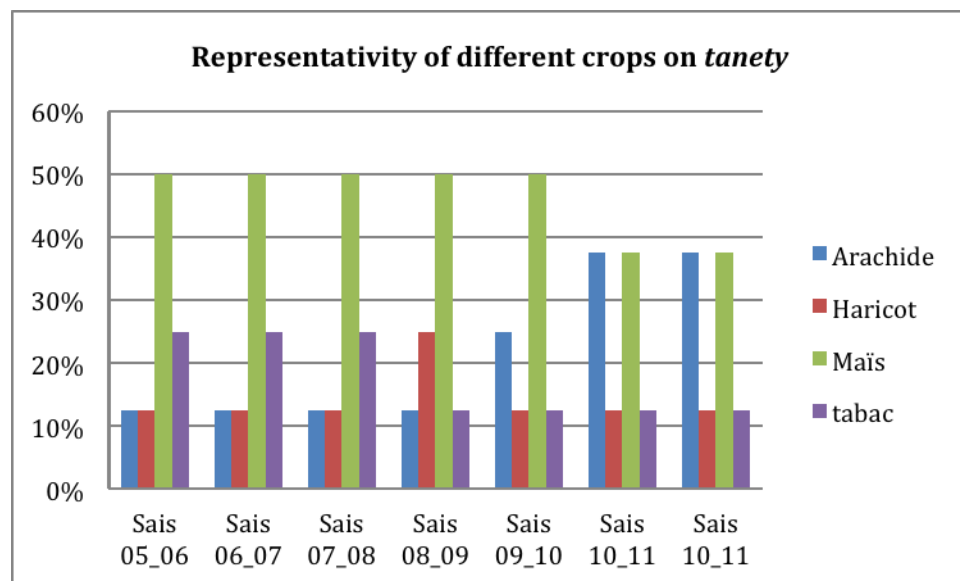


Figure 13 : Ratios (%) of presence of each crop over the total of surveyed plots for each campaign

On *tanety* on in the north no agronomic rotation was observed. The plots are cultivated in monoculture of maize, groundnuts, beans and tobacco. However, since the 2009-2010 campaign one can observe a change in practices (introduction of a rotation: peanut with maize), confirmed by the plot plans of the farmers for the campaign 2011-2012. This explains the increase of peanuts among other crops since 2006-2007 to 2011. However the change is too recent to correctly identify the rotation. We can make two hypothesis to explain this change in practice: the rise in input prices in 2008-2009 combined with the launch of the second phase of the BV-Lac has led to a slowdown in cultures with high levels of inputs (maize, rice) and an acceleration of less intensive crops such as groundnuts. Groundnuts are moreover better value than maize crop (correct yields at low input, high sales price).

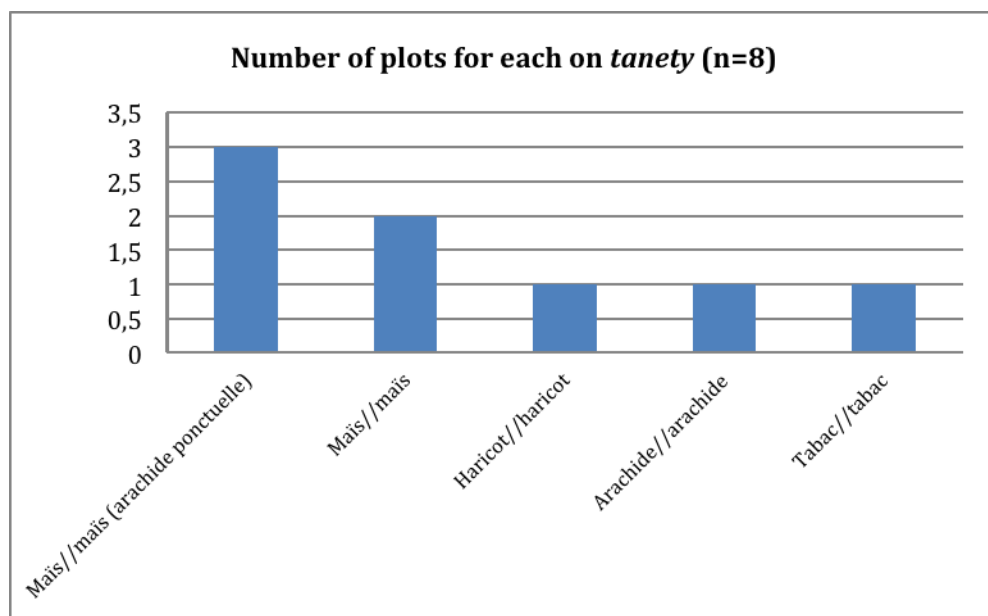


Figure 14: rotations on *tanety* on the surveyed plots in 2011 (n=8)

Maize monoculture is mainly represented. We will keep the following standard crop sequence: **maize//maize//groundnut**.

APPENDIX 9: THE STANDARD TECHNICAL PATHWAYS

Standard crop technical pathways are based on the results of 2007-2008 campaign.

1. Innovative crop technical pathways

The innovative crop technical pathways are built from standard technical pathways BRL 2007-2008 in year 0 of CA (with Tillage). Data on plant covers are removed (seeds, gauchó, time to work). When data are available, these pathways are detailed by toposequence and area.

i. Standard innovative technical pathway for Cassava

Standard				B	T et TBP
	Period	Work time hour/ha	Cost W	Quantity/ha	Quantity/ha
Tillage	déc – 1	60	MO Fam	-	-
Transplanting	déc – 1	120	MO Fam	12500 tiges	8200 tiges
Fertilisation - Manure	Nov – 1	10	MO Fam	1417kg	1633 kg
Weeding 1	Avr – 1	125	MO Fam	-	-
Weeding 2	Juin – 1	72	MO Fam	-	-
Harvest	Oct – 1	163	MO Fam	-	-

Toposequence	B	T et TBP
Yield (kg/ha)	3500	2300

ii. Standard innovative technical pathway for Maize VSE

T	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 1	98	MO Fam	-
Sowing	Déc – 2	150	MO Fam	30 kg
Fertilisation - Manure	Déc – 1	-	MO Fam	3292 kg
Gauchó	Déc – 2	-	MO Fam	72 g
Weeding 1	Janv – 2	200	MO Fam	-
Weeding 2	Fév – 2	200	MO Fam	-
Harvest	Avril – 2	182	MO Fam	-

TBP	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 2	91	MO Fam	-
Sowing	Janv – 1	150	MO Fam	29 kg
Fertilisation - Manure	Déc – 2	-	MO Fam	2679 kg
Gauchó	Janv – 1	-	MO Fam	82,50 g
Weeding 1	Fév – 1	200	MO Fam	-

Weeding 2	Mars – 1	200	MO Fam	-
Harvest	Mai – 1	196	MO Fam	-

B	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 1	128	MO Fam	-
Sowing	Déc – 2	150	MO Fam	26 kg
Fertilisation - Manure	Déc – 1	-	MO Fam	4000 kg
Gaicho	Déc – 2	-	MO Fam	58 g
Weeding 1	Janv – 2	200	MO Fam	-
Weeding 2	Fév – 2	200	MO Fam	-
Harvest	Avril – 2	209	MO Fam	-

Toposequence	B	TBP	T
Yield (kg/ha)	2060	2212	1981

iii. Standard innovative technical pathway for Maize ZNE

T	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 2	112	MO Fam	-
Sowing	Janv – 1	150	MO Fam	25 kg
Fertilisation - Manure	Janv – 1	-	MO Fam	2773 kg
Gaicho	Janv – 2	-	MO Fam	83 g
Weeding 1	Févr – 1	200	MO Fam	-
Weeding 2	Mars – 1	200	MO Fam	-
Harvest	Juin – 2	217	MO Fam	-

TBP	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 2	140	MO Fam	-
Sowing	Janv – 1	150	MO Fam	27 kg
Fumure – Poudrette	Déc – 2	-	MO Fam	4072 kg
Gaicho	Janv – 1	-	MO Fam	79 g
Weeding 1	Févr – 1	200	MO Fam	-
Weeding 2	Mars – 1	200	MO Fam	-
Harvest	Juin – 1	245	MO Fam	-

B	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 1	119	MO Fam	-
Sowing	Déc – 2	150	MO Fam	26 kg
Fertilisation - Manure	Déc – 1	-	MO Fam	2968 kg
Gaicho	Déc – 2	-	MO Fam	58 g
Weeding 1	Janv – 2	200	MO Fam	-
Weeding 2	Fév – 2	200	MO Fam	-

Harvest	Juin –1	210	MO Fam	-
----------------	---------	-----	--------	---

Toposequence	B	TBP	T
Yield (kg/ha)	1623	2188	1835

iv. Standard innovative technical pathway for Upland rice VSE

T	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 1	60	MO Fam	-
Sowing	Déc – 2	238	MO Fam	57 kg
Fertilisation - Manure	Déc – 2	-	MO Fam	4091 kg
Gaicho	Déc – 2	-	MO Fam	155 g
Weeding 1	Janv – 2	250	MO Fam	-
Weeding 2	Fév – 2	250	MO Fam	-
Harvest	Avril – 2	217	MO Fam	-

TBP	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 1	105	MO Fam	-
Sowing	Déc – 2	238	MO Fam	62 kg
Fertilisation - Manure	Déc – 2	-	MO Fam	2673 kg
Gaicho	Déc – 2	-	MO Fam	153 g
Weeding 1	Janv – 2	200	MO Fam	-
Weeding 2	Fév – 2	200	MO Fam	-
Harvest	Avril – 1	245	MO Fam	-

B	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 1	100	MO Fam	-
Sowing	Déc – 2	238	MO Fam	64 kg
Fertilisation - Manure	Déc – 2	-	MO Fam	2643 kg
Gaicho	Déc – 2	-	MO Fam	160 g
Weeding 1	Janv – 2	200	MO Fam	-
Weeding 2	Fév – 2	200	MO Fam	-
Harvest	Avril – 1	231	MO Fam	-

Toposequence	B	TBP	T
Yield (kg/ha)	2544	2395	1658

v. Standard innovative technical pathway for Upland rice ZNE

T	Period	Work time hour/ha	Cost W	Quantity/ha
----------	---------------	--------------------------	---------------	--------------------

Tillage	Déc – 1	105	MO Fam	-
Sowing	Déc – 2	189	MO Fam	59 kg
Fertilisation - Manure	Déc – 2	-	MO Fam	2445 kg
Gaicho	Déc – 2	-	MO Fam	147 g
Weeding 1	Janv – 2	200	MO Fam	-
Harvest	Avril – 2	210	MO Fam	-

TBP	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 1	112	MO Fam	-
Sowing	Déc – 2	224	MO Fam	56 kg
Fertilisation - Manure	Déc – 2	-	MO Fam	2265 kg
Gaicho	Déc – 2	-	MO Fam	139 g
Weeding 1	Janv – 2	200	MO Fam	-
Weeding 2	Fév – 2	200	MO Fam	-
Harvest	Avril – 2	245	MO Fam	-

B	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 1	112	MO Fam	-
Sowing	Déc – 2	280	MO Fam	57 kg
Fertilisation - Manure	Déc – 1	-	MO Fam	2900 kg
Gaicho	Déc – 2	-	MO Fam	143 g
Urée	Déc – 1	14	MO Fam	72 kg
NPK	Déc – 1	14	MO Fam	109 kg
Weeding 1	Janv – 2	200	MO Fam	-
Weeding 2	Fév – 2	200	MO Fam	-
Harvest	Avr – 1	287	MO Fam	-

Toposequence	B	TBP	T
Yield (kg/ha)	2117	2152	1860

vi. Standard innovative technical pathway for Groundnut VSE

B	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 2	98	MO Fam	-
Sowing	Janv – 1	210	MO Fam	50 kg
Weeding 1	Févr – 1	196	MO Fam	-
Weeding 2	Mars – 1	196	MO Fam	-
Harvest	Mai – 2	259	MO Fam	-

T	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 2	105	MO Fam	-
Sowing	Janv – 1	224	MO Fam	53 kg
Weeding 1	Févr – 1	182	MO Fam	-

Harvest	Juin – 1	273	MO Fam	-
----------------	----------	-----	--------	---

Toposequence	B	T
Yield (kg/ha)	1113	890

vii. Standard innovative technical pathway for Groundnut ZNE

T	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 2	120	MO Fam	-
Sowing	Janv – 1	231	MO Fam	63 kg
Weeding 1	Févr – 1	126	MO Fam	-
Weeding 2	Mars – 1	126	MO Fam	-
Harvest	Juin – 1	238	MO Fam	-

Toposequence	T
Yield (kg/ha)	896

viii. Standard innovative technical pathway for Beans DS

	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Avr – 2	89	MO Fam	-
Sowing	Mai – 1	300	MO Fam	60 kg
Fertilisation - Manure	Avr – 2	-	MO Fam	2716 kg
NPK	Avr – 2		MO Fam	61 kg
Weeding 1	Mai – 2	57	MO Fam	-
Cyperméthrine	Juin – 1	34	MO Fam	0,60 L
Glyphosate	Juin – 2	38	MO Fam	5 L
Harvest	Aout – 1	196	MO Fam	-

Toposequence	B
Yield (kg/ha)	693

ix. Standard innovative technical pathway for Beans VSE

TBP	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 2	138	MO Fam	-
Sowing	Janv – 1	254	MO Fam	59 kg
NPK	Déc – 2	-	MO Fam	62 kg
Weeding 1	Févr – 1	64	MO Fam	-
Harvest	Avril – 1	201	MO Fam	-

Toposequence	TBP
Yield (kg/ha)	426

2. CA crop technical pathway in year 0

Ca crop technical pathways in year 0 were established from standard CTP of BRL for the 2007-2008 campaign.

i. Maize + leguminous CA_0 VSE

T	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 1	98	MO Fam	
Sowing	Déc – 2	301	MO Fam	30 kg maïs 21 kg dolichos
Fertilisation - Manure	Déc – 1	-	MO Fam	3292 kg
Gaúcho	Déc – 2	-	MO Fam	122 g
Weeding 1	Janv – 2	231	MO Fam	-
Harvest	Avril – 2	182	MO Fam	-

T	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 1	126	MO Fam	
Sowing	Déc – 2	196	MO Fam	30 kg maïs 15 kg vigna
Fertilisation - Manure	Déc – 1	-	MO Fam	1667 kg
NPK	Déc – 2	-		20 kg
Gaúcho	Déc – 2	-	MO Fam	93 g
Weeding 1	Janv – 2	203	MO Fam	-
Harvest	Avril – 2	138	MO Fam	-

TBP	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 2	91	MO Fam	
Sowing	Janv – 1	245	MO Fam	29 kg maïs 16 kg dolichos
Fertilisation - Manure	Déc – 2	-	MO Fam	2679 kg
Gaúcho	Janv – 1	-	MO Fam	128 g
Weeding 1	Fév – 2	196	MO Fam	-
Harvest	Mai – 1	196	MO Fam	-

B	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 1	128	MO Fam	
Sowing	Déc – 2	236	MO Fam	26 kg maïs 21 kg dolichos
Fertilisation - Manure	Déc – 1	-	MO Fam	4000
Gaúcho	Déc – 2	-	MO Fam	105 g
Weeding 1	Janv – 1	258	MO Fam	-
Harvest	Avril – 2	209	MO Fam	-

Toposequence	B	TBP	T
Yield (kg/ha) A0	2060	2212	1981

ii. Maize + leguminous CA_0 ZNE

T	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 2	112	MO Fam	-
Sowing	Janv – 2	224	MO Fam	25 kg maïs 20 kg dolichos
Fertilisation - Manure	Janv – 1	-	MO Fam	2773 kg
Gaicho	Janv – 2	-	MO Fam	130 g
Weeding 1	Févr – 1	231	MO Fam	-
Harvest	Juin – 2	217	MO Fam	-

T	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 1	126	MO Fam	-
Sowing	Déc – 2	196	MO Fam	30 kg maïs 15 kg vigna
Fertilisation - Manure	Déc – 1	-	MO Fam	1667 kg
NPK	Déc – 2	-	MO Fam	20 kg
Gaicho	Déc – 2	-	MO Fam	93g
Weeding 1	Janv – 2	203	MO Fam	-
Harvest	Avril – 2	238	MO Fam	-

TBP	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 2	140	MO Fam	-
Sowing	Janv – 1	252	MO Fam	27 kg maïs 19 kg dolichos
Fertilisation - Manure	Déc – 2	-	MO Fam	4072 kg
Gaicho	Janv – 1	-	MO Fam	134g
Weeding 1	Févr – 1	280	MO Fam	-
Harvest	Juin – 1	245	MO Fam	-

TBP	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 2	140	MO Fam	-
Sowing	Janv – 1	252	MO Fam	27 kg maïs 14 kg vigna
Fertilisation - Manure	Déc – 2	-	MO Fam	4072 kg
Gaicho	Janv – 1	-	MO Fam	134g
Weeding 1	Févr – 1	280	MO Fam	-
Harvest	Juin – 1	245	MO Fam	-

B	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 1	119	MO Fam	-
Sowing	Déc – 2	224	MO Fam	26 kg maïs 21 kg dolichos

Fertilisation - Manure	Déc – 1	-	MO Fam	2968 kg
Gaicho	Déc – 2	-	MO Fam	91 g
Weeding 1	Févr – 1	210	MO Fam	-
Harvest	Juin – 1	210	MO Fam	-

Toposequence	B	TBP	T
Yield (kg/ha) A0	1623	2188	1835

iii. Upland rice CA_0 VSE

T	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 1	42	MO Fam	-
Sowing	Déc – 2	238	MO Fam	57 kg
Fertilisation - Manure	Déc – 1	-	MO Fam	4091 kg
Gaicho	Déc – 2	-	MO Fam	155 g
Weeding 1	Janv – 2	200	MO Fam	-
Weeding 2	Févr – 2	200	MO Fam	-
Harvest	Avril – 2	217	MO Fam	-

TBP	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 1	105	MO Fam	-
Sowing	Déc – 2	238	MO Fam	62 kg
Fertilisation - Manure	Déc – 1	-	MO Fam	2673 kg
Gaicho	Déc – 2	-	MO Fam	153 g
Weeding 1	Janv – 2	158	MO Fam	-
Weeding 2	Févr – 2	158	MO Fam	-
Harvest	Avril – 1	245	MO Fam	-

B	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 1	98	MO Fam	-
Sowing	Déc – 2	238	MO Fam	64 kg
Fertilisation - Manure	Déc – 1	-	MO Fam	2643 kg
Gaicho	Déc – 2	-	MO Fam	160 g
Weeding 1	Janv – 2	137	MO Fam	-
Weeding 2	Févr – 2	137	MO Fam	-
Harvest	Avril – 1	231	MO Fam	-

Toposequence	B	TBP	T
Yield (kg/ha) A0	2544	2395	1658

iv. Upland rice CA_0 ZNE

T	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 1	105	MO Fam	-
Sowing	Déc – 2	189	MO Fam	59 kg
Fertilisation - Manure	Déc – 1	-	MO Fam	2445 kg
Gaicho	Déc – 2	-	MO Fam	147 g
Weeding 1	Janv – 2	154	MO Fam	-
Harvest	Avril – 2	210	MO Fam	-

TBP	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 1	112	MO Fam	-
Sowing	Déc – 2	224	MO Fam	56 kg
Fertilisation - Manure	Déc – 1	-	MO Fam	2265 kg
Gaicho	Déc – 2	-	MO Fam	139 g
Weeding 1	Janv – 2	112	MO Fam	-
Weeding 2	Févr – 2	112	MO Fam	-
Harvest	Avril – 2	245	MO Fam	-

B	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 1	112	MO Fam	-
Sowing	Déc – 2	280	MO Fam	60 kg
Fertilisation - Manure	Déc – 1	-	MO Fam	4641 kg
Gaicho	Déc – 2	-	MO Fam	149 g
NPK	Déc – 1	-	MO Fam	98 kg
Weeding 1	Janv – 2	151	MO Fam	-
Weeding 2	Févr – 2	151	MO Fam	-
Harvest	Avril – 1	287	MO Fam	-

Toposequence	B	TBP	T
Yield (kg/ha) A0	2117	2152	1860

v. Groundnut CA_0 VSE

B	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 2	98	MO Fam	-
Sowing	Janv – 1	210	MO Fam	50 kg
Weeding 1	Févr – 1	196	MO Fam	-
Weeding 2	Mars – 1	196	MO Fam	-
Harvest	Mai – 2	259	MO Fam	-

T	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 2	105	MO Fam	-
Sowing	Janv – 1	224	MO Fam	53 kg

Weeding 1	Févr – 1	182	MO Fam	-
Harvest	Juin – 1	273	MO Fam	-

Toposequence	B	T
Yield (kg/ha) A0	1043	890

vi. Groundnut CA_0 ZNE

T	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Déc – 2	120	MO Fam	-
Sowing	Janv – 1	231	MO Fam	63 kg
Weeding 1	Févr – 1	126	MO Fam	-
Weeding 2	Mars – 1	126	MO Fam	-
Harvest	Juin – 1	238	MO Fam	-

Toposequence	T
Yield (kg/ha) A0	896

vii. Beans + vetch DS CA_0

B	Period	Work time hour/ha	Cost W	Quantity/ha
Tillage	Avril – 2	89	MO Fam	-
Sowing	Mai – 1	393	MO Fam	60 kg haricot 5 kg vetch
Fertilisation - Manure	Avr – 2	-	MO Fam	2716 kg
NPK		-		61 kg
Weeding 1	Mai – 2	57	MO Fam	-
Cyperméthrine	Juin – 1	34		0,60 L
Glyphosate	Juin – 2	38		5 L
Harvest	Aout – 1	196	MO Fam	-

Toposequence	B
Yield (kg/ha)	693

3. CA crop technical pathways in year n+1 (T1 to Y9)

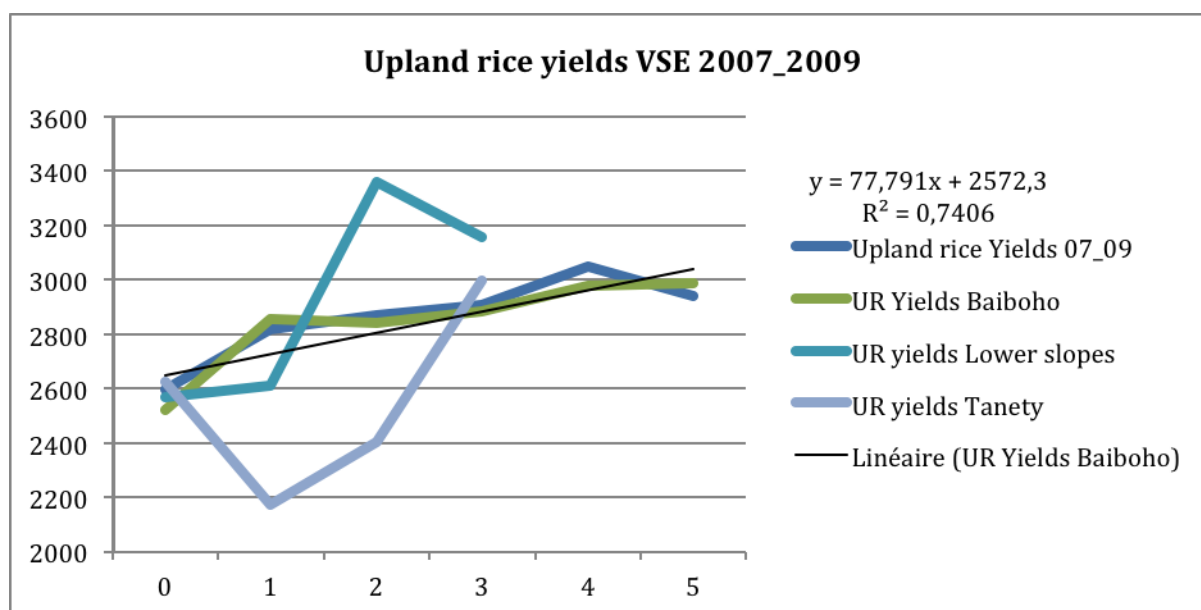
CA crop technical pathways are built from standard CTP in year 0. The time of tillage are eliminated.

APPENDIX 10: EVOLUTION OF YIELDS AND OF RETURN TO LABOUR ACCORDING TO THE AGE IN CA

The graphs below are built from BRL databases for 2007-2008 and 2008-2009 campaigns. These graphs show the evolution of yields from year 0 of CA until year 4 or 5. From year 4, the number of plots is not sufficient for analysis (less than 3 plots).

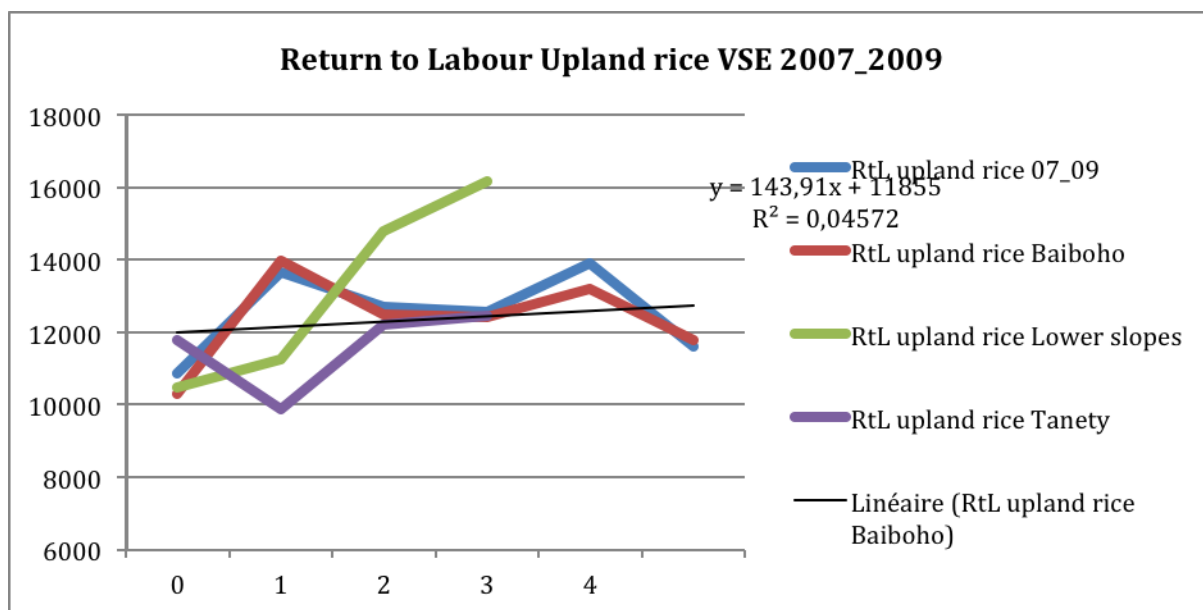
1. Evolution of yields and of return to labour in VSE area

i. Upland rice VSE



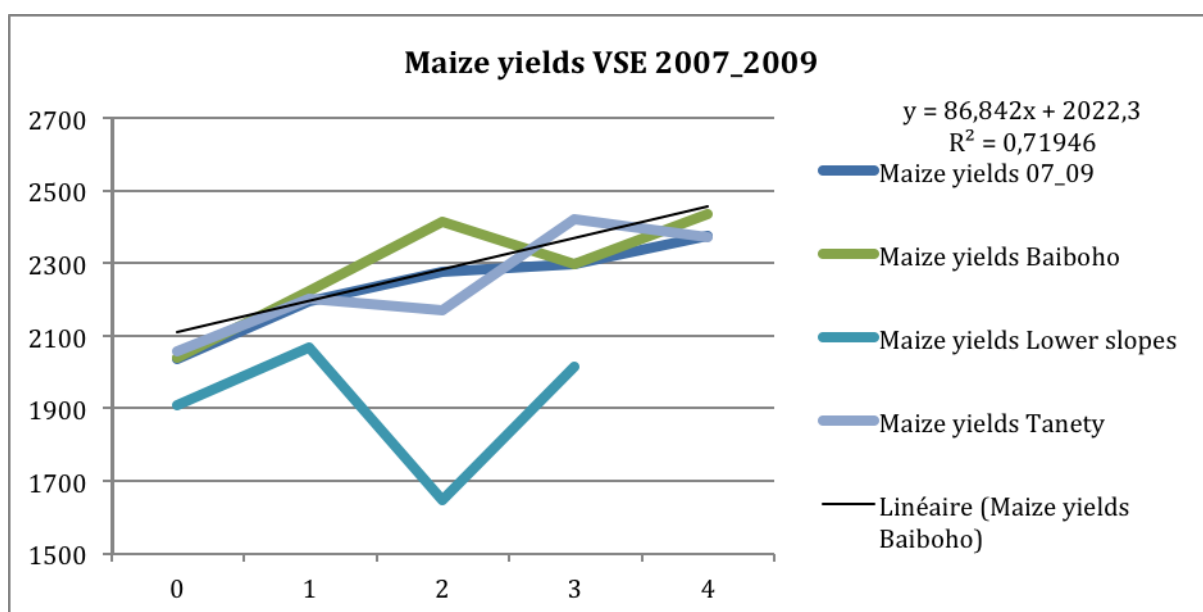
Note: « rdt riz pluvial 07-09 » represents the average yield on al 3 toposequences

The yields of upland rice on *baiboho* increase oby 3% per year in average. The yields appear to be stabilizing on *baiboho* to 3000 kg/ha after the fifth year of CA. We lack data on older plots to confirm the trend over ten years. Modelling is carried out over ten years with a yield of standard BRL baiboho of 2544 kg/ha in year 0. The improved yield after ten years of CA is 687 kg/ha.

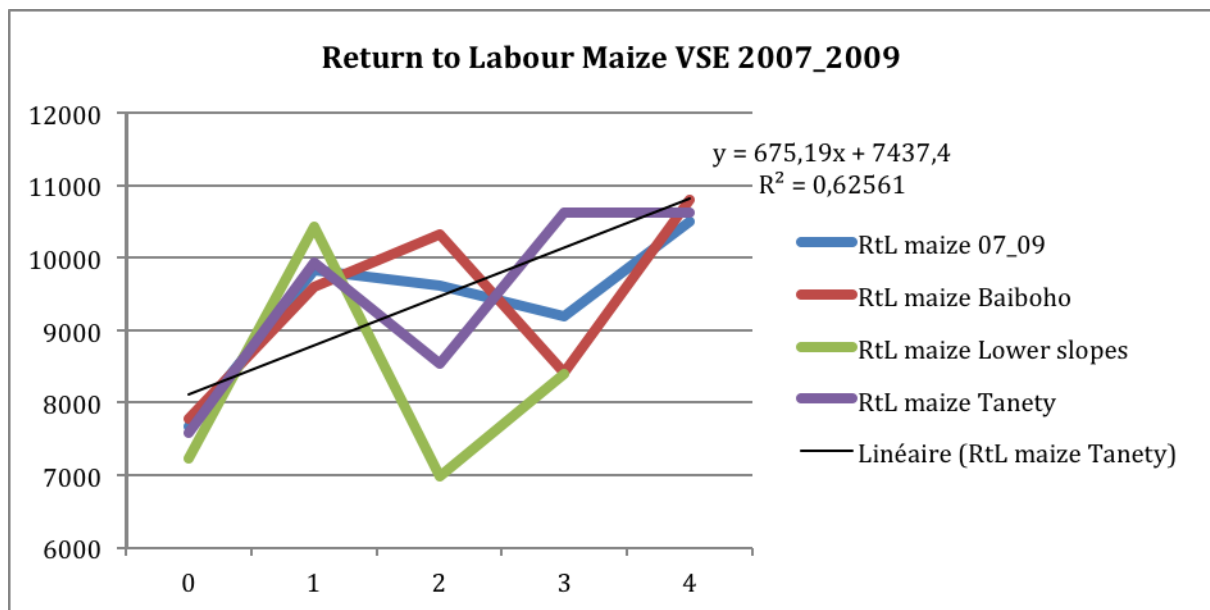


Return to labour increases by 1% per year in average. Return to labour increases in the first year of CA due to the stop of plowing. Return to labour does not increase as much as yields, reflecting an increase in operational costs of 2% in average. This increase is due to increased time weeding the first years.

ii. Maize VSE

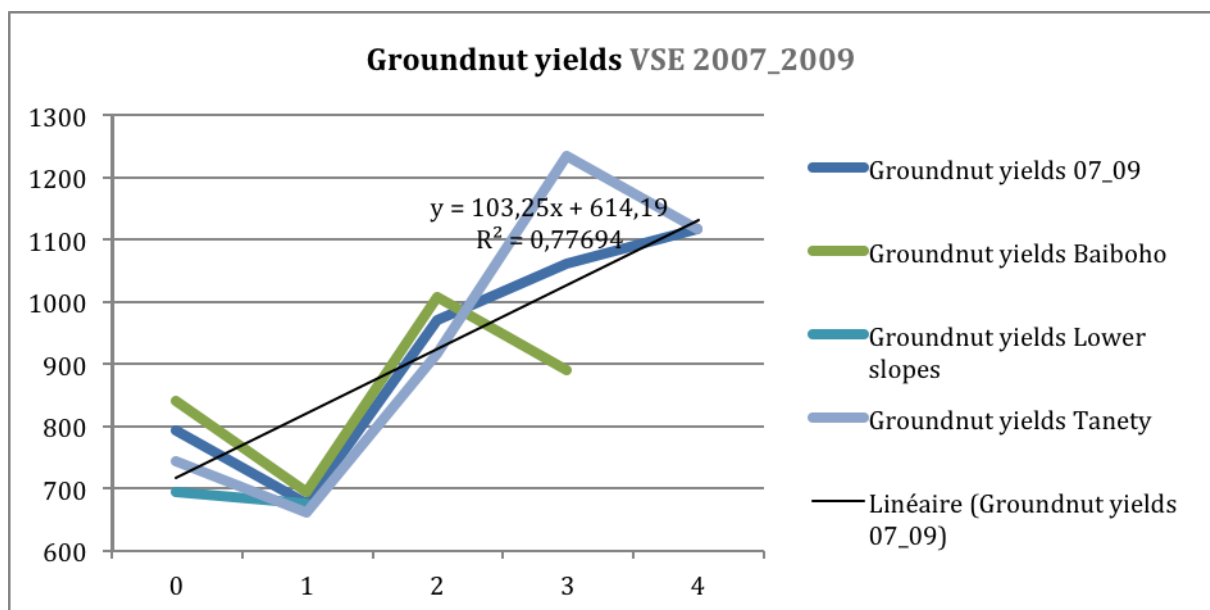


Maize yields increased by 4% per year in average. Modelling is carried out over ten years with a standard BRL yield on *baiboho* of 2060 kg/ha in year 0. The yield is improved after ten years of CA by 742 kg/ha.

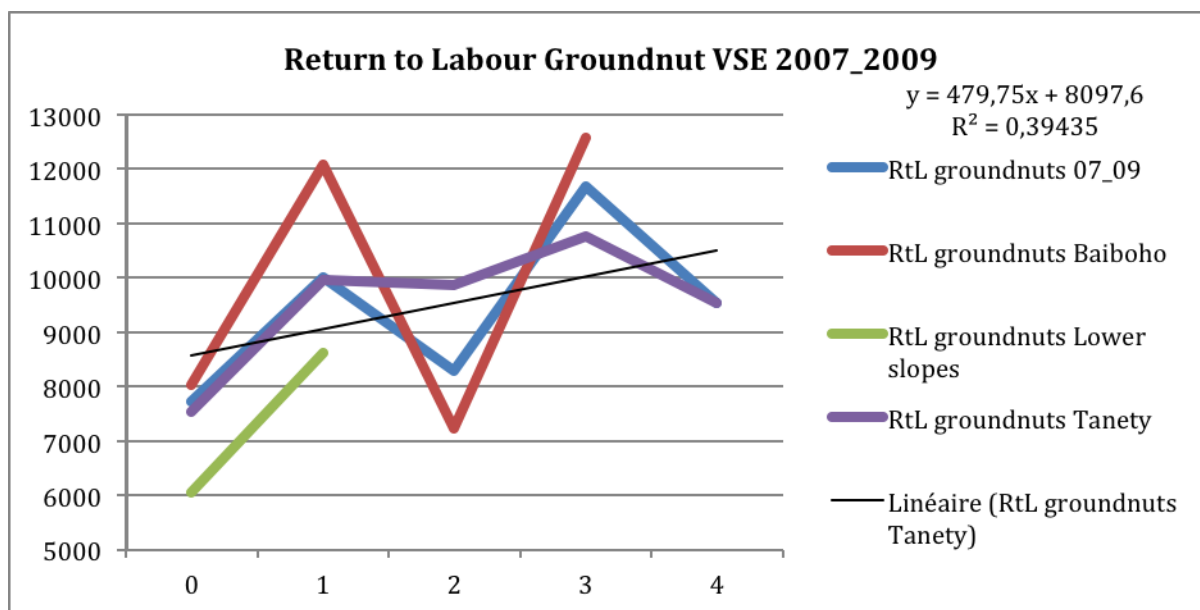


Return to labour increases of 6% per year in average. Return to labour increases in the first year of CA due to stop of plowing. Return to labour increases more strongly than yields. This can be explained by a decrease in workload including in weeding.

iii. Groundnut VSE



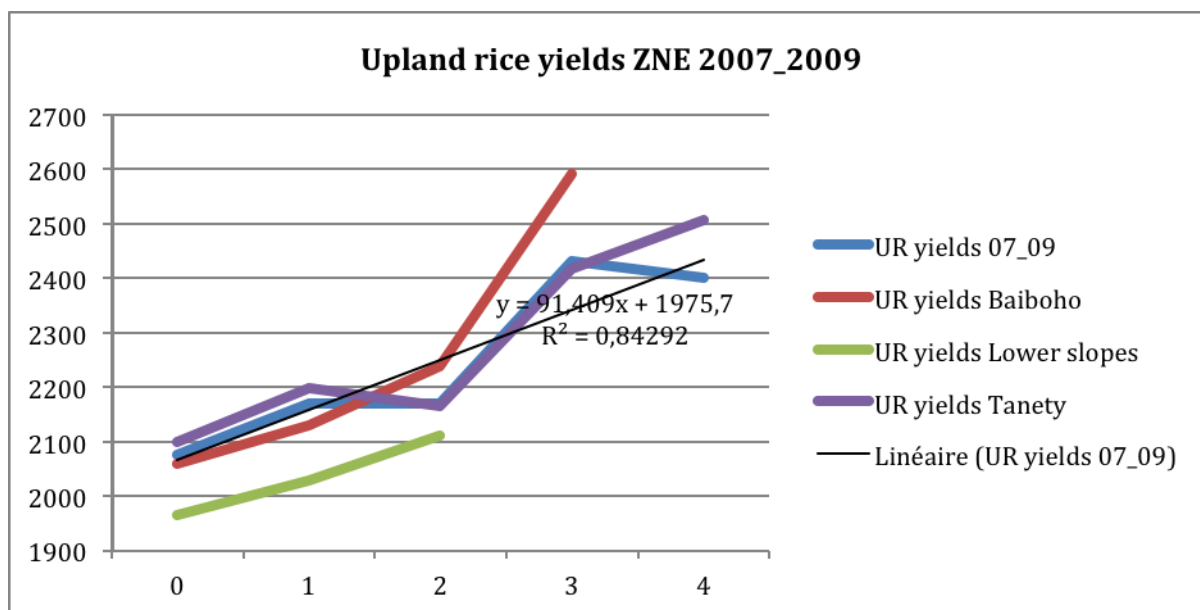
Groundnut yields increased by 16% per year according to the data, but the yield is at a low starting point in the southeast, 750 kg/ha on average. This increased is not applicable for 10 years of modelling as the BRL standard yields used (1043 kg/ha); has already reached the potential of culture in the soil conditions of the lake Aloatra (personal communication, technical assistant CA).



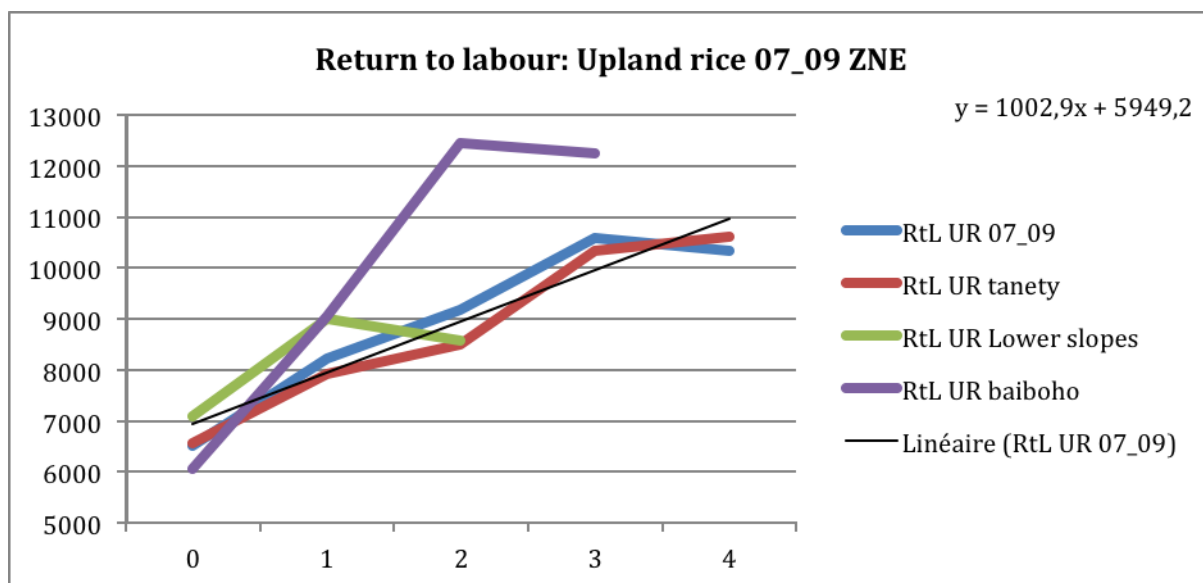
Return to labour increases by 7% per year in average. Return to labour increases also in the first year of CA due to stop of tillage. The increase in yields is not directly seen on the return to labour. This may be due to an increased in operational costs, including time for weeding.

2. Evolution of yields and of return to labour in ZNE area

i. Upland rice ZNE

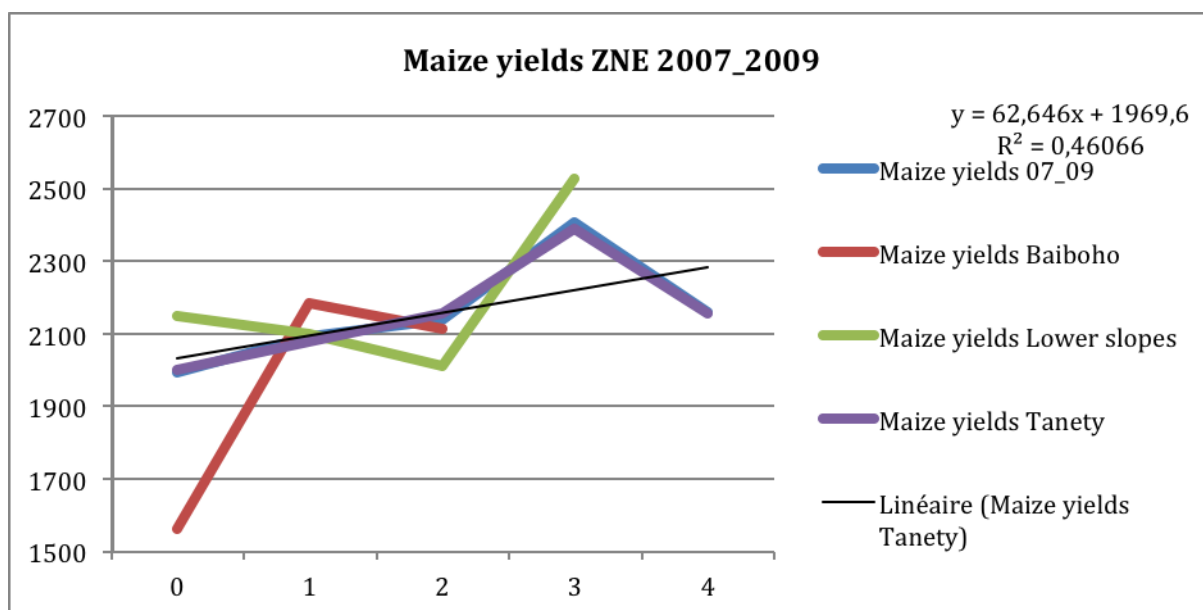


The yields of upland rice on *baiboho* increase by 5% per year in average. We apply this increase in yields over 10 years for modelling. The selected standard BRL yield on *baiboho* is 2117 kg/ha in year 0. The yield is improved after ten years of CA by 953 kg/ha.

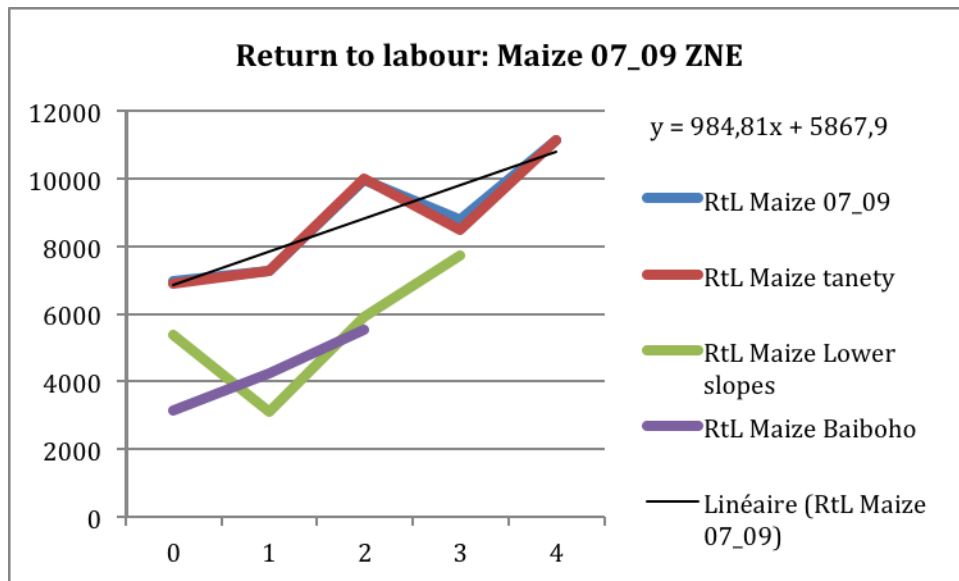


Return to labour increased by 17% per year. Return to labour increases more strongly than yields. This can be explained by the stop of tillage on the one hand, and the reduced weeding time on the other hand.

ii. Maize ZNE

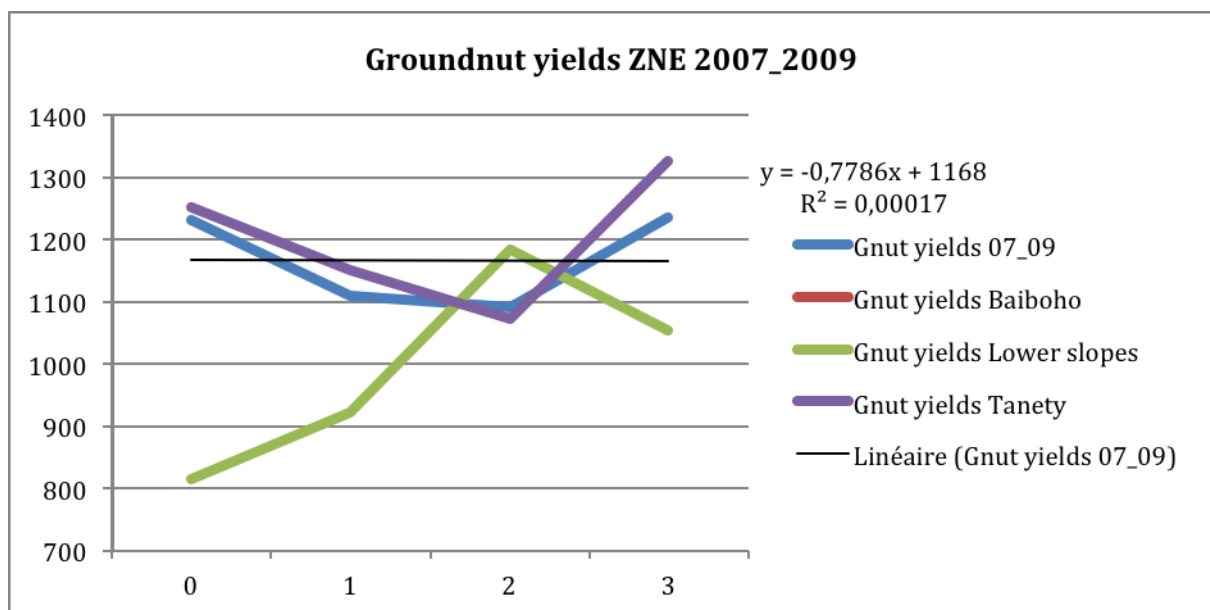


Maize yields increased by 3% per year in average. This increase in yields is applied to all toposequences over 10 years. Standard BRL yield on *baiboho* is 1623 kg/ha in year 0. The yield is improved after ten years of CA by 438 kg/ha.

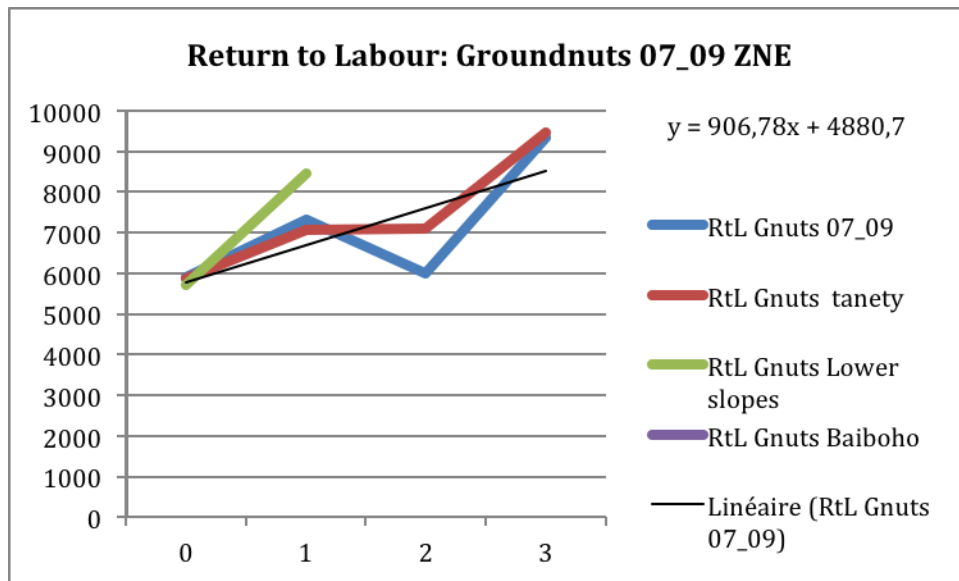


Return to labour increased by 17% per year in average. It is increasing faster than the yield in the same way as in the southeast; this can be explained by a decrease in work time.

iii. Groundnut ZNE



Groundnut yields are stable at 1150 kg/ha on the overall. We won't apply any increase on yields for modelling since the standard BRL yield used for modelling is 1043 kg/ha.



Return to labour increases by 19% per year in average. The yields being stable this increase can be explained by a sharp decrease in work time.

In conclusion, we have chosen to apply the same average yield increase per crop and per area for all the toposequence. The changes observed in return to labour for each crop are not applied for modelling. The available data do not validate trends. Indeed, full crop technical pathways are collected on only 10% of the monitored plots. It is assumed that these crops managements are collected from the most performing farmers, which would explain the difference between the evolution of return to labour and yields. For example for the groundnut, the average yield stagnates in the northeast while return to labour increases by 19%.

APPENDIX 11: MODELISED FARMS

I. Farms of the north-east area

1. General data of the type C farm

Code Olympe:M704

Name: RANDRIAMIARINTSAINA Zakamarosoa

Zone: northeast

Fokontany: Imerimandroso

Village: Ambaniala

Status: monitored by BRL since 2005

Type: C

	IPF	PWCPF	Baiboho	Tanety	Total
Land tenure status	<i>Owned</i>	<i>Owned</i>	<i>Owned</i>	<i>Owned</i>	<i>Owned</i>
Number of hectares	1,50	0,80	0,12	0,57	2,99
Number of plots	3	1	2	5	11

Selfsufficient in rice: yes

Off-farm income: fishing 400 000 Ar/year equivalent to 1/3 of total net income

Notes:

- 0,10 ha of *eucalyptus* on *tanety*
- 0,02 ha of fruit trees on *baiboho*
- 0,08 ha of *tanety* did not exist before 2008

2. Evolution of the effective crop rotation from 2007 to 2011 and prevision for 2011-2012

	06-07		07-08		08-09		09-10		10-11		11-12 prevision	
IPF_ 1,50ha	Irrigate d rice		Irrigate d rice		Irrigate d rice		Irrigate d rice		Irrigate d rice		Irrigate d rice	
PWCPF – 0,80ha	Upland rice (MK34)	Rice DS Boeing (RD)	Upland rice (MK34)	Rice DS Boeing (RD)	Upland rice (MK34)	rice DS Boeing (RD)	Upland rice (MK34)	rice DS Boeing (RD)	Upland rice (MK34)	rice DS Boeing (RD)	Upland rice (MK34)	rice DS Boeing (RD)
Tanety BP_ 0,15 ha	Dolichos		MAIZE Dolichos		Cowpea		Maize VIGN		Groundnut Maize		Maize Dolichos	
Tanety BP_ 0,10 ha	MAIZE Cowpea		Upland rice		Maize Cowp		Upland rice		Maize VIGN		Upland rice	
Tanety_ 0,08 ha					Maize cowpe		Maize VIGN		Maize VIGN		Maize NIEB	
TanetyB P 0,14ha	Maize Cowp		Upland rice B22		Cassava BRACC.		Maize VIGN		Upland rice B22		Cassava BRACC.	
Baiboho _0,10 ha	Upland rice Mulch	Potatoe DS	Upland rice mulch	Potatoe DS	Upland rice mulch	Potatoes DS	Upland rice mulch	Potatoe DS	Upland rice mulch	Potatoe DS	Upland rice mulch	potatoe DS

3. Crop rotation of the type D farm

Table 9: Crop rotation expressed in hectares in standard CA system over 10 year for the type D farm in the ZNE area

	0	1	2	3	4	5	6	7	8	9	10
Upland rice_ PWCPF	1	1	1	1	1	1	1	1	1	1	1
DS rice_ PWCPF	1	1	1	1	1	1	1	1	1	1	1
Maize+dolichos_TBP	0,15		0,10	0,14	0,15		0,10	0,14	0,15		0,10
Upland rice_TBP	0,14	0,15		0,10	0,14	0,15		0,10	0,14	0,15	
Maize+dolichos_TBP	0,10	0,14	0,15		0,10	0,14	0,15		0,10	0,14	0,15
Groundnut_TBP		0,10	0,14	0,15		0,10	0,14	0,15		0,10	0,14
Maize+dolichos_T		0,08				0,08				0,08	
Upland rice_T			0,08				0,08				0,08
Maize+dolichos_T				0,08				0,08			
Groundnut_T	0,08				0,08				0,08		
Upland rice_B	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10
Beans + vetch_B (DS)	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10

Table 10: Crop rotation expressed in hectares in standard ICS system over 10 year for the type D farm in the ZNE area

	0	1	2	3	4	5	6	7	8	9	10
Upland rice_ PWCPF	1	1	1	1	1	1	1	1	1	1	1
DS rice_ PWCPF	1	1	1	1	1	1	1	1	1	1	1
Upland rice_TBP	0,15	0,10	0,14	0,15	0,10	0,14	0,15	0,10	0,14	0,15	0,10
Maize_TBP	0,14	0,15	0,10	0,14	0,15	0,10	0,14	0,15	0,10	0,14	0,15
Groundnut_TBP	0,10	0,14	0,15	0,10	0,14	0,15	0,10	0,14	0,15	0,10	0,14
Maize_T		0,08			0,08			0,08			0,08
Maize_T			0,08			0,08			0,08		
Groundnut_T	0,08			0,08			0,08			0,08	
Upland rice_B	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10
Beans_B (DS)	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10

Table 11: Crop rotation expressed in hectares in standard conventional system over 10 year for the type D farm in the ZNE

	0	1	2	3	4	5	6	7	8	9	10
Upland rice_ PWCPF	1	1	1	1	1	1	1	1	1	1	1
DS rice_ PWCPF	1	1	1	1	1	1	1	1	1	1	1
Maize_TBP	0,39	0,39	0,39	0,39	0,39	0,39	0,39	0,39	0,39	0,39	0,39
Maize_T	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08
Upland rice_B	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10
Beans_B (DS)	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10

4. Crop rotation of the type E farm

Tableau 12 : Crop rotation expressed in hectares in standard CA system over 10 year for the type E farm in the ZNE area

	0	1	2	3	4	5	6	7	8	9	10
Upland rice_ PWCPF	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5
DS rice_ PWCPF	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5
Maize+dolichos_TBP	0,15		0,10	0,14	0,15		0,10	0,14	0,15		0,10
Upland rice_TBP	0,14	0,15		0,10	0,14	0,15		0,10	0,14	0,15	
Maize+dolichos_TBP	0,10	0,14	0,15		0,10	0,14	0,15		0,10	0,14	0,15
Groundnut_TBP		0,10	0,14	0,15		0,10	0,14	0,15		0,10	0,14
Maize+dolichos_T		0,08				0,08				0,08	
Upland rice_T			0,08				0,08				0,08
Maize+dolichos_T				0,08				0,08			
Groundnut_T	0,08				0,08				0,08		
Upland rice_B	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10
Beans + vetch_B (DS)	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10

Table 13 : Crop rotation expressed in hectares in standard ICS system over 10 year for the type E farm in the ZNE area

	0	1	2	3	4	5	6	7	8	9	10
Upland rice_ PWCPF	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5
DS rice_ PWCPF	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5
Upland rice_TBP	0,15	0,10	0,14	0,15	0,10	0,14	0,15	0,10	0,14	0,15	0,10
Maize_TBP	0,14	0,15	0,10	0,14	0,15	0,10	0,14	0,15	0,10	0,14	0,15
Groundnut_TBP	0,10	0,14	0,15	0,10	0,14	0,15	0,10	0,14	0,15	0,10	0,14
Maize_T		0,08			0,08			0,08			0,08
Maize_T			0,08			0,08			0,08		
Groundnut_T	0,08			0,08			0,08			0,08	
Upland rice_B	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10
Beans_B (DS)	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10

Table 14 : Crop rotation expressed in hectares in standard conventional system over 10 year for the type E farm in the ZNE

	0	1	2	3	4	5	6	7	8	9	10
Upland rice_ PWCPF	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5
DS rice_ PWCPF	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5
Maize_TBP	0,39	0,39	0,39	0,39	0,39	0,39	0,39	0,39	0,39	0,39	0,39
Maize_T	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08	0,08
Upland rice_B	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10
Beans_B (DS)	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10	0,10

II. Farms of the southeast valley

1. General data of the type C farm

Code Olympe :M1301

Name : RAKOTOARY Ernest

Zone: southeast

Fokontany : Ambohipasika

Village: Ambohipasika

Status: monitored by BRL since 2007

Type: C

	IPF	Baiboho		Total	
Land tenure status	<i>Owned</i>	<i>Owned</i>	<i>Rented</i>	<i>Owned</i>	<i>Rented</i>
Number of hectares	1,50	0,20	0,10	1,70	0,1
Number of plots	1	2	1	3	1

Selfsufficient in rice: yes

Off-farm income: agricultural worker 400 000 Ar/year

2. Evolution of the effective crop rotation from 2007 to 2011 and prevision for 2011-2012

3. Crop rotation of the type D farm

Table 15 : Crop rotation expressed in hectares in standard CA system over 10 year for the type D farm in the VSE area

	0	1	2	3	4	5	6	7	8	9	10
Upland rice PWCPF	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5
Maize+dolichos B	0,08	0,1	0,08	0,1	0,08	0,1	0,08	0,1	0,08	0,1	0,08
Upland rice B	0,1	0,08	0,1	0,08	0,1	0,08	0,1	0,08	0,1	0,08	0,1
Upland rice_B	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12
	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05
Beans + vetch_B (DS)	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12
	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05

Table 16 : Crop rotation expressed in hectares in standard ICS system over 10 year for the type E farm in the VSE area

	0	1	2	3	4	5	6	7	8	9	10
Upland rice PWCPF	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5
Upland rice B	0,08		0,1	0,08		0,1	0,08		0,1	0,08	
Maize B	0,1	0,08		0,1	0,08		0,1	0,08		0,1	0,08
Groundnut B		0,1	0,08		0,1	0,08		0,1	0,08		0,1
Upland rice_B	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12
	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05
Beans B (DS)	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12
	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05

4. Crop rotation of the type E farm

Table 17 : Crop rotation expressed in hectares in standard CA system over 10 year for the type E farm in the VSE area

	0	1	2	3	4	5	6	7	8	9	10
Upland rice PWCPF	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9
Maize+dolichos B	0,08	0,1	0,08	0,1	0,08	0,1	0,08	0,1	0,08	0,1	0,08
Upland rice B	0,1	0,08	0,1	0,08	0,1	0,08	0,1	0,08	0,1	0,08	0,1
Upland rice_B	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12
	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05
Beans + vetch_B (DS)	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12
	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05

Table 18 : Crop rotation expressed in hectares in standard ICS system over 10 year for the type E farm in the VSE area

	0	1	2	3	4	5	6	7	8	9	10
Upland rice PWCPF	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9	0,9
Upland rice B	0,08		0,1	0,08		0,1	0,08		0,1	0,08	
Maize B	0,1	0,08		0,1	0,08		0,1	0,08		0,1	0,08
Groundnut B		0,1	0,08		0,1	0,08		0,1	0,08		0,1
Upland rice_B	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12
	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05
Beans B (DS)	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12	0,12
	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05

APPENDIX 12: ECONOMIC ANALYSIS

Part I: Economic Indicators

The tables below are direct outputs from the software olympe. They present the results in kilo Ariary (kAr or x 1000 Ar) of the following economic indicators: gross margin (*marge brute*), farm income (*résultat*) (Σ of the net margins or net farm income calculated before selfconsumption) net margin (*marge nette*), total net income, cash balance (*solde*) (FNI- Σ household expenses including self consumption \Leftrightarrow annual house) et cumulated cash balance (*solde cumulé*) over 10 years. The detailed calculations of these indicators are presented in appendix 6. These indicators are calculated for each cropping system (horizontally): CA, ICS and conventional, at farm level for each year (vertically) over 10 years.

- I. Zone southeast
 - a. Type C farm in the southeast area

Unité	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Marge										
M1301_Modèle SCV_VSE_11kar	3 305	3 313	3 333	3 341	3 361	3 368	3 389	3 396	3 417	3 424
M1301_Modèle Innov_VSE_1'kar	3 291	3 254	3 301	3 291	3 254	3 301	3 291	3 254	3 301	3 276
Résultat										
M1301_Modèle SCV_VSE_11kar	3 061	3 069	3 089	3 096	3 117	3 124	3 144	3 151	3 172	3 179
M1301_Modèle Innov_VSE_1'kar	3 046	3 009	3 056	3 046	3 009	3 056	3 046	3 009	3 056	3 032
Marge nette										
M1301_Modèle SCV_VSE_11	2 016	2 024	2 044	1 983	2 004	2 011	2 031	2 038	2 059	2 066
M1301_Modèle Innov_VSE_1' 11	2 001	1 964	2 011	1 933	1 896	1 943	1 933	1 896	1 943	1 919
Revenu total net										
M1301_Modèle SCV_VSE_11	3 061	3 069	3 089	3 096	3 117	3 124	3 144	3 151	3 172	3 179
M1301_Modèle Innov_VSE_1' 11	3 046	3 009	3 056	3 046	3 009	3 056	3 046	3 009	3 056	3 032
Solde										
M1301_Modèle SCV_VSE_11kar	1 456	1 464	1 484	1 423	1 444	1 451	1 471	1 478	1 499	1 506
M1301_Modèle Innov_VSE_1'kar	1 441	1 404	1 451	1 373	1 336	1 383	1 373	1 336	1 383	1 359
Solde Cumul										
M1301_Modèle SCV_VSE_11kar	1 456	2 919	4 403	5 826	7 269	8 720	10 191	11 670	13 169	14 675
M1301_Modèle Innov_VSE_1'kar	1 441	2 845	4 296	5 669	7 006	8 388	9 762	11 098	12 481	13 839

Figure 15 : Values of economic indicators over 10 years for the type C farm of the VSE area

The total farm income is equal to the net farm income because there is no off farm. There is a 5% difference in the total farm income after 10 years of CA compared to the ICS system. The cumulated cash balance over 10 years show a difference of 6% between the two systems.

b. Type D farm in the southeast area

Unité	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Marge										
Modele type D SCV VSE 11 kar	2 475	3 271	3 291	3 299	3 319	3 326	3 347	3 354	3 375	3 382
Modele type D Innov VSE 11 kar	2 520	1 780	3 258	1 817	699	2 530	1 817	3 212	1 826	722
Résultat										
Modele type D SCV VSE 11 kar	2 217	3 026	3 046	3 054	3 074	3 081	3 102	3 109	3 130	3 137
Modele type D Innov VSE 11 kar	2 262	1 535	3 013	1 572	455	2 285	1 572	2 967	1 582	477
Marge nette										
Modele type D SCV VSE 11	1 172	1 981	2 001	1 941	1 961	1 968	1 989	1 996	2 017	2 024
Modele type D Innov VSE 11	1 217	490	1 968	459	-658	1 172	459	1 854	469	-636
Revenu total net										
Modele type D SCV VSE 11	2 217	3 026	3 046	3 054	3 074	3 081	3 102	3 109	3 130	3 137
Modele type D Innov VSE 11	2 262	1 535	3 013	1 572	455	2 285	1 572	2 967	1 582	477
Solde										
Modele type D SCV VSE 11 kar	612	1 421	1 441	1 381	1 401	1 408	1 429	1 436	1 457	1 464
Modele type D Innov VSE 11 kar	657	-70	1 408	-101	-1 218	612	-101	1 294	-91	-1 196
Solde Cumul										
Modele type D SCV VSE 11 kar	612	2 033	3 474	4 855	6 256	7 664	9 093	10 529	11 986	13 450
Modele type D Innov VSE 11 kar	657	587	1 996	1 895	676	1 288	1 187	2 481	2 390	1 194

Figure 16 : Values of economic indicators over 10 years for the type D farm of the VSE area

We observe in year 5 and 10 a drop in the farm gross margin and therefore the farm net income (as FNI = no off-farm income) in the ICS system. This is the drop in production of rice on PWCPF (driving system non CA) due to a climate accident (zero production). In CA system, the PWCPF (technical pathway in CA) is subject to little or no climate hazard. After 10 years, the cumulated cash balance indicates a difference of 91% between ICS and CA systems. A very bad year, the farm income is higher by 85% in CA system compared to ICS while for a good year the farm income is higher by 26% in CA system than in ICS. Yields gradually increase in CA system while in the ICS system yields are sensitive to climatic hazards.

c. Type E farm in the southeast area

Unité	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Marge										
Modele type E SCV VSE 11 1kar	1 884	2 321	2 334	2 335	2 348	2 348	2 362	2 361	2 375	2 375
Modele type E Innov VSE 11 kar	1 869	1 410	2 316	1 447	762	1 879	1 447	2 269	1 457	784
Résultat										
Modele type E SCV VSE 11 1kar	1 871	2 321	2 334	2 335	2 348	2 348	2 362	2 361	2 375	2 375
Modele type E Innov VSE 11 kar	1 612	1 165	2 071	1 202	517	1 634	1 202	2 024	1 212	540
Marge nette										
Modele type E SCV VSE 11 1kar	826	1 276	1 289	1 222	1 235	1 235	1 249	1 248	1 262	1 262
Modele type E Innov VSE 11 kar	567	120	1 026	89	-596	521	89	911	99	-573
Revenu total net										
Modele type E SCV VSE 11 1kar	2 271	2 721	2 734	2 735	2 748	2 748	2 762	2 761	2 775	2 775
Modele type E Innov VSE 11 kar	2 012	1 565	2 471	1 602	917	2 034	1 602	2 424	1 612	940
Solde										
Modele type E SCV VSE 11 1kar	666	1 116	1 129	1 062	1 075	1 075	1 089	1 088	1 102	1 102
Modele type E Innov VSE 11 kar	241	-206	700	-141	-826	291	-141	681	-131	-803
Solde Cumul										
Modele type E SCV VSE 11 1kar	666	1 782	2 911	3 973	5 048	6 123	7 212	8 300	9 403	10 505
Modele type E Innov VSE 11 kar	241	35	735	594	-232	59	-81	600	469	-335

Figure 17 : Values of economic indicators over 10 years for the type E farm of the VSE area

The Farm Net Income (FNI) is about 78% greater in AC system in a very bad year compared to the other systems. The FNI is higher because the farm has an off-farm income of 400 000 Ar/year. The cash balance in the system gradually increases each year in CA system while in ICS it varies according to the weather conditions. Years 2, 4, 5, 7, 9 and 10 years which are average to poor the cash balance is negative. The farmer is not self-sufficient in rice and has to buy the one hand, and secondly, he must invest in the implementation of crops of the following year. The cumulated cash balance after 10 years in CA system is higher by 103% than the cumulated cash balance in the ICS system. The farm system is losing money in ICS.

II. Northeast area

a. Type C farm in the northeast area

Unité	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Marge										
M704_Modele SCV type C_1kar	4 310	3 842	4 547	3 848	3 188	4 388	3 879	4 634	3 978	3 250
M704_Modele Innov Type C_1kar1	4 247	3 744	4 474	3 769	2 997	4 235	3 769	4 461	3 757	3 052
M704_Modele Conv Type C_1kar11	4 185	3 707	4 425	3 707	2 960	4 185	3 707	4 425	3 707	2 960
Résultat										
M704_Modele SCV type C_1kar	4 275	3 812	4 517	3 818	3 158	4 358	3 849	4 604	3 948	3 220
M704_Modele Innov Type C_1kar1	4 211	3 714	4 444	3 739	2 967	4 205	3 739	4 431	3 727	3 022
M704_Modele Conv Type C_1kar11	4 150	3 677	4 395	3 677	2 930	4 155	3 677	4 395	3 677	2 930
Marge nette										
M704_Modele SCV type C_11	3 392	2 929	3 634	2 935	2 275	3 475	2 967	3 722	3 065	2 337
M704_Modele Innov Type C_1 11	3 329	2 831	3 562	2 856	2 085	3 323	2 856	3 549	2 844	2 140
M704_Modele Conv Type C_1 111	3 267	2 795	3 512	2 795	2 048	3 273	2 795	3 512	2 795	2 048
Revenu total net										
M704_Modele SCV type C_11	4 675	4 212	4 917	4 218	3 558	4 758	4 249	5 004	4 348	3 620
M704_Modele Innov Type C_1 11	4 611	4 114	4 844	4 139	3 367	4 605	4 139	4 831	4 127	3 422
M704_Modele Conv Type C_1 111	4 550	4 077	4 795	4 077	3 330	4 555	4 077	4 795	4 077	3 330
Solde										
M704_Modele SCV type C_1kar	2 832	2 369	3 024	2 325	1 665	2 865	2 357	3 112	2 455	1 727
M704_Modele Innov Type C_1kar1	2 769	2 271	2 952	2 246	1 475	2 713	2 246	2 939	2 234	1 530
M704_Modele Conv Type C_1kar11	2 707	2 235	2 902	2 185	1 438	2 663	2 185	2 902	2 185	1 438
Solde Cumul										
M704_Modele SCV type C_1kar	2 832	5 201	8 225	10 550	12 216	15 081	17 437	20 549	23 004	24 732
M704_Modele Innov Type C_1kar1	2 769	5 040	7 992	10 238	11 713	14 425	16 671	19 610	21 845	23 374
M704_Modele Conv Type C_1kar11	2 707	4 942	7 844	10 028	11 466	14 129	16 313	19 215	21 400	22 837

Figure 18 : Values of economic indicators over 10 years for the type C farm of the ZNE area

The type C farm showed no significant difference between the CA systems, ICS and conventional. The cumulated balance over 10 years in CA system is higher than the ICS system by only 5.5% and 7.7% compared to conventional system. The cumulated cash balance of the ICS system is greater by 3.3% compared to the cash balance of the conventional system after 10 years.

b. Type D farms in the northeast area

Unité	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Marge										
Modele type D_SCV Sarra_11kar	3 283	2 705	3 601	2 734	1 907	3 417	2 801	3 747	2 922	2 027
Modele type D_Innov Sarra_1kar21	3 199	2 577	3 486	2 601	1 651	3 188	2 601	3 474	2 590	1 706
Modele type D_Conventionnelkarra_11 12113 138	2 540	3 437	2 540	1 614	3 138	2 540	3 437	2 540	1 614	
Résultat										
Modele type D_SCV Sarra_11kar	3 247	2 675	3 571	2 704	1 877	3 387	2 771	3 717	2 892	1 997
Modele type D_Innov Sarra_1kar21	3 164	2 547	3 456	2 571	1 621	3 158	2 571	3 444	2 560	1 676
Modele type D_Conventionnelkarra_11 12113 102	2 510	3 407	2 510	1 584	3 108	2 510	3 407	2 510	1 584	
Marge nette										
Modele type D_SCV Sarra_11 12	2 364	1 793	2 688	1 822	994	2 505	1 888	2 834	2 010	1 115
Modele type D_Innov Sarra_1 121	2 281	1 664	2 574	1 689	738	2 275	1 689	2 561	1 677	793
Modele type D_Conventionnel sarra_11 12112 220	1 627	2 524	1 627	701	2 225	1 627	2 524	1 627	701	
Revenu total net										
Modele type D_SCV Sarra_11 12	3 647	3 075	3 971	3 104	2 277	3 787	3 171	4 117	3 292	2 397
Modele type D_Innov Sarra_1 121	3 564	2 947	3 856	2 971	2 021	3 558	2 971	3 844	2 960	2 076
Modele type D_Conventionnel sarra_11 12113 502	2 910	3 807	2 910	1 984	3 508	2 910	3 807	2 910	1 984	
Solde										
Modele type D_SCV Sarra_11kar	1 804	1 233	2 078	1 212	384	1 895	1 278	2 224	1 400	505
Modele type D_Innov Sarra_1kar21	1 721	1 104	1 964	1 079	128	1 665	1 079	1 951	1 067	183
Modele type D_Conventionnelkarra_11 12111 660	1 067	1 914	1 017	91	1 615	1 017	1 914	1 017	91	
Solde Cumul										
Modele type D_SCV Sarra_11kar	1 804	3 037	5 115	6 327	6 711	8 606	9 884	12 108	13 508	14 012
Modele type D_Innov Sarra_1kar21	1 721	2 825	4 789	5 868	5 996	7 661	8 740	10 691	11 758	11 941
Modele type D_Conventionnelkarra_11 12111 660	2 727	4 641	5 658	5 749	7 364	8 382	10 296	11 313	11 404	

Figure 19: Values of economic indicators over 10 years for the type D farm of the ZNE area

The cumulated cash balance over 10 years in CA system is 15% higher than in ICS system and 18% higher than in conventional system. The difference in the cash balance between the AC system and other systems is growing from the sixth year onwards. Between ICS and conventional systems the cash balance is only different in bad years (about 50% higher in ICS).

c. Type E farm in the Northeast area

Unité	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Marge										
Modele type E_SCV Sarra_11kar	2 300	2 021	2 469	2 051	1 671	2 435	2 117	2 615	2 239	1 792
Modele type E_Innov Sarra_1'kar1	2 217	1 893	2 354	1 918	1 415	2 205	1 918	2 341	1 906	1 470
Modele type E Conventionnel karra_11 1411 2 155	2 155	1 856	2 305	1 856	1 378	2 155	1 856	2 305	1 856	1 378
Résultat										
Modele type E_SCV Sarra_11kar	2 264	1 991	2 439	2 021	1 641	2 405	2 087	2 585	2 209	1 762
Modele type E_Innov Sarra_1'kar1	2 181	1 863	2 324	1 888	1 385	2 175	1 888	2 311	1 876	1 440
Modele type E Conventionnel karra_11 1411 2 120	2 120	1 826	2 275	1 826	1 348	2 125	1 826	2 275	1 826	1 348
Marge nette										
Modele type E_SCV Sarra_11 14	1 382	1 109	1 556	1 138	759	1 522	1 204	1 702	1 326	879
Modele type E_Innov Sarra_1' 141	1 298	980	1 442	1 005	503	1 292	1 005	1 429	993	558
Modele type E Conventionnel arra_11 1411 1 237	1 237	944	1 392	944	466	1 242	944	1 392	944	466
Revenu total net										
Modele type E_SCV Sarra_11 14	2 664	2 391	2 839	2 421	2 041	2 805	2 487	2 985	2 609	2 162
Modele type E_Innov Sarra_1' 141	2 581	2 263	2 724	2 288	1 785	2 575	2 288	2 711	2 276	1 840
Modele type E Conventionnel arra_11 1411 2 520	2 520	2 226	2 675	2 226	1 748	2 525	2 226	2 675	2 226	1 748
Solde										
Modele type E_SCV Sarra_11kar	822	437	926	510	135	884	585	1 092	712	250
Modele type E_Innov Sarra_1'kar1	738	420	832	395	-179	682	395	819	383	-65
Modele type E Conventionnel karra_11 1411 677	677	384	782	334	-216	632	334	782	334	-157
Solde Cumul										
Modele type E_SCV Sarra_11kar	822	1 259	2 185	2 695	2 830	3 713	4 299	5 391	6 103	6 353
Modele type E_Innov Sarra_1'kar1	738	1 159	1 991	2 386	2 206	2 889	3 284	4 103	4 486	4 421
Modele type E Conventionnel karra_11 1411 677	677	1 060	1 842	2 176	1 960	2 592	2 926	3 708	4 041	3 884

Figure 20 : Values of economic indicators over 10 years for the type E farm of the ZNE area

The cash balance in years 5 and 10 is negative so there's de-capitalization: this farm is not sustainable in the medium term for conventional systems and ICS. The farmer is not self-sufficient in rice. The cumulated cash balance after 10 years in CA system is higher by 30% than in ICS, and 39% compared to conventional system. This difference is significant and directly related to cropping systems on upland soils, the influence of the PWCPF system is less significant on this type of farm.

Partie II : Work Calenders

I. Comparison of work calenders of CA systems and ICS on *baiboho*

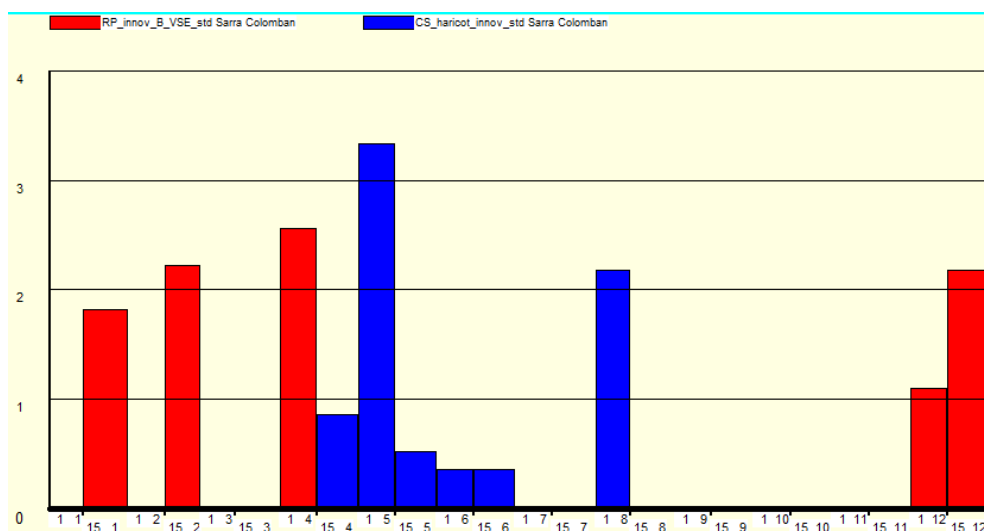


Figure 21 : Work calendar of the CA system Upland rice + vetch – DS on mulch on *baiboho* of 1 hectare

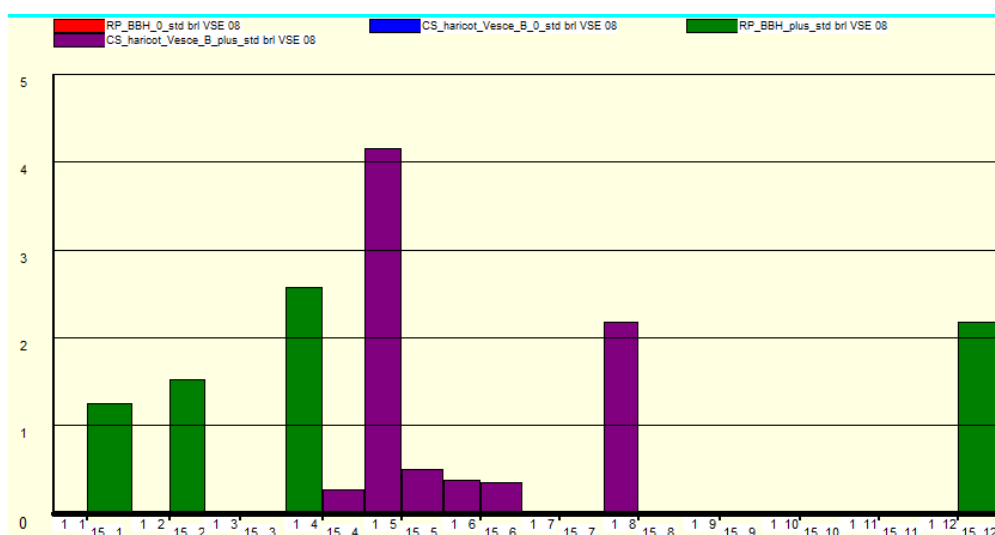


Figure 22 : Work calendar of the ICS system Upland rice – DS on mulch on *baiboho* of 1 hectare

These graphs show on the x-axis work months of the year (1 = January 2 = February, etc.) detailed by two weeks for a year. On the y-axis, the numbers 1 to 5 correspond to the number of labour units mobilized. Overall, we observe in the two systems work peaks in March, April, August and December. This corresponds respectively to the rice harvest during the rainy season, the development of the dry season crop, and it's harvest, and the introduction of rice cultivation for the next season. Note that overall the ICS system mobilizes more labour units for the management of the system than the CA system. In April, this is the time of plowing in ICS, absent in the CA system (installation of mulch). In December, there is similarly a time of plowing in ICS absent in CA. In January and February there is the weeding of rice in ICS it mobilizes more labour units than in CA systems (the cover crop can reduce working time, by limiting the weeds).

II. Comparison of work calendars of the CA system and ICS on *tanety*

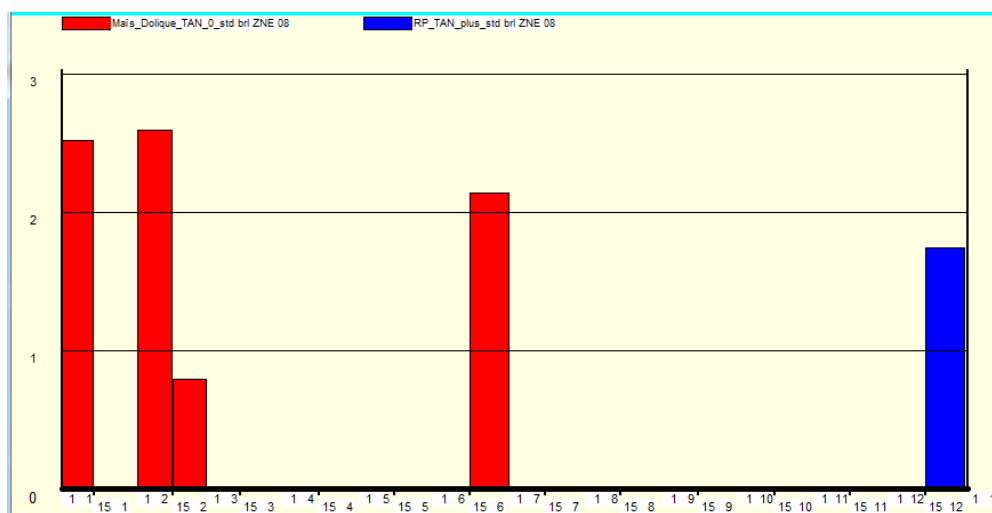


Figure 23 : Work calendar of the CA system maize + dolichos // upland rice // maize+ dolichos // groundnut on *tanety* of 1 hectare

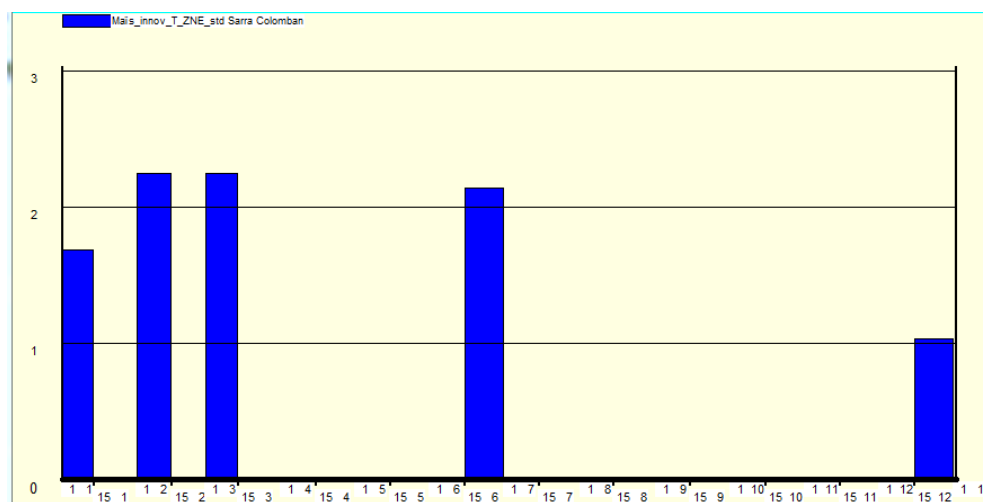


Figure 24 : Work calendar of the ICS system maize // maize // groundnut on *tanety*

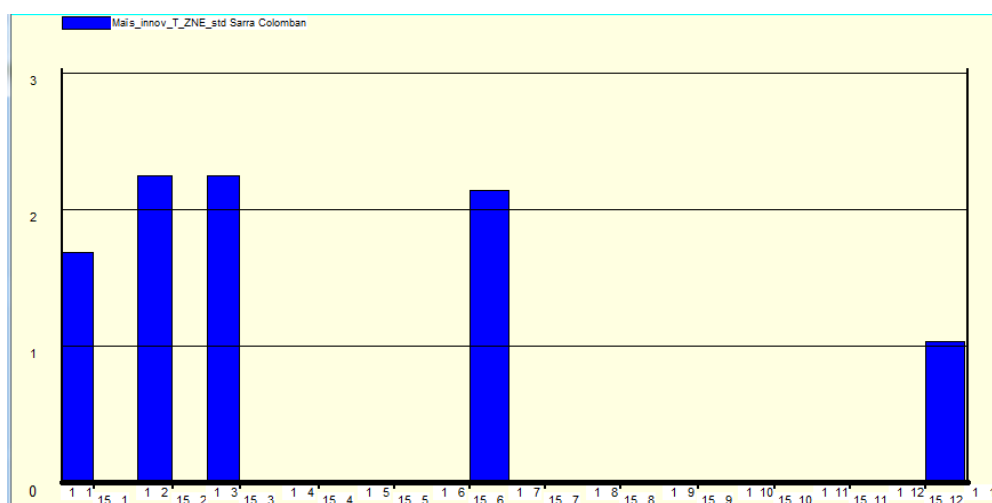


Figure 25 : Work calendar of the conventional system : maize // maize on *tanety* of 1 hectare

Peaks in workload are observed on the three systems in January, February, June and December. This corresponds in CA systems respectively to the maize planting, weeding, harvesting and the introduction of rice cultivation for the next season. This calendar corresponds to the first year of implementation of the system, only the first two crops of the rotation (maize+Dolichos and upland rice) appear. In ICS system peaks correspond to the work for setting up maize, weeding, harvesting and development of the maize following crop. As in CA system, the calendar is the year of implementation of the system, the cultivation of groundnuts in the third position in the rotation does not appear. These peaks of work in conventional system are the same as in ICS. It is observed that conventional systems and ICS are identical in terms of work schedule on the maize crop. Only the rotation practiced differentiates the two systems. However, there are some differences in CA system. The introduction of maize associated with dolichos mobilizes more labour units than ICS or conventional system. The first weeding is also longer in the CA system. This can be explained by the fact that the cover crop is being installed, it may not cover completely the soil, weeding is more difficult since it is necessary to weed between the cover crop and food crop. However the second weeding system in CA is significantly faster than in ICS or conventional system. The cover crop (dolichos) also allows to reduce working time by two by limiting weeds.